

Odonata from southwest of central desert of Iran with occurrence notes on *Ischnura intermedia* Dumontm, 1974

Kiany, M. and Sadeghi, S.*

Department of Biology, College of Sciences, Shiraz University, Shiraz, I.R. of Iran

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Karizes (Qanat) prepare a part of fresh water sources in main desert of Iran. The arid regions in deserts have isolated suitable aquatic habitats as strong barriers, thus only a few places with surface waters have remained accessible for water-related insects. This paper represents the results of only study on dragonfly species of Karizes. We identified 10 species of typical desert dragonflies of four different families that were collected in summer 2013. Some traits allow Odonata to exist in deserts; hence they may reveal some differences with those in non-desert regions. No endemic species was found in this part of the desert. we concluded that there are typical opportunistic species with special adaptations that could colonize in Karizes as a type of aquatic habitats. We reported *Ischnura intermedia* here as a new record for Iran and noted some of its differences with the type specimen.

Key words: Karizes, Odonata, Yazd province, Kavir

INTRODUCTION

The exact knowledge of Odonata fauna in Iranian deserts is not currently available. Indeed, it would always have been expected that Odonata should be absent or poorly represented in desert environments. In deserts, ephemeral or temporary streams or ponds may be created by occasional precipitation (Jacobson et al. 1995). The lotic and semi-lotic reservoirs (canals, irrigation troughs etc) play a main role in patchiness or mosaic patterns of distribution of dragonflies in deserts. Some artificial wells and connecting tunnels have constituted these habitats and provided new colonizable areas for dragonflies (Borisov, 1985a, 2006). Dragonflies quickly colonize in newly formed artificial reservoirs and thus they are able to distribute rapidly. Fast larval development in some species allows inhabiting temporary reservoirs (Borisov, 2006). Water lifting devices pump water from underground sources in deserts and create temporary water bodies and ephemeral streams. This position exists particularly in northern Africa, Arabia (Suhling and et al. 2003) and other arid areas as well. Desert habitats are unique and including unique and beautiful dragonflies.

Efficient flight allows dragonflies to occupy long distant habitats and enables them to colonize even in the most isolated areas. Migration patterns differ between two suborders of Odonata. Some migrant dragonflies use their robust flying muscles and wind flows but among damselflies, air movements have main role because of their small size. Some species of genus *Ischnura* represent interesting migration; *I. evansi* appeared at the light in night, intermittently at desert oasis in Arabia. In the regions with temporal discontinuity of habitat imposed by seasonal drought, obligate migration occurs (Corbet, 2004).

*Corresponding Author: ssadeghi@shirazu.ac.ir

In the great central deserts of Iran, Karizes (Qanats) are the main permanent water sources that used for drinking water and agriculture. Kariz technology was innovated in Iran between eighth and tenth centuries BC (Lightfoot, 2000). The people in dry areas have invented a peculiar technology as Kariz system for withdrawing a part of the fresh underground water (Ahmadi, 2010, Babaev, 2008; Ghanbarpour, 2007; Lightfoot, 2000). The origin of some Karizes' (in Old Zavareh) can be traced back to 5000 years ago with a main well with 350 m depth. Some also have 29 km. length with 966 shafts (Ahmadi, 2010; Ghanbarpour, 2000)]. These water systems provide the only accessible and permanent water sources in that area that can be inhabited by dragonflies and other water- related insects throughout the year. However, continuation of drought conditions reduces water discharge of the system and may be led to destroy some branches. Although, deserts and mountains are important geographical barriers in normal distribution of dragonflies, scattered water sources in deserts can provide suitable condition for them to disperse. Some anisopters are able to flying across deserts as well as other places but in Zygoptera, most species such as *I. intermedia* cannot, thus they are limited to the central and southwest parts of Iran. Dispersal patterns and direction are important factors for tracking of the species. Molecular studies can also provide informative evidence for understanding the patterns of dispersal. The main goal in this research was to gather data about fauna and distribution of dragonflies in a part of the Lut desert and investigating the Karizes' role on their dispersion.

MATERIAL AND METHODS

Specimens were collected from three localities in Yazd province: Yazd (31°55'N, 54°22'E), Taft (31°44'N, 54°10'E) and Mehriz (31°33'N, 54°25'E). Adult dragonflies and damselflies were collected using a hand net with suitable handle. Some specimens were put in triangle paper envelop and some others preserved in ethyl alcohol 70%. At the laboratory, some specimens were immersed in pure acetone for fixing their colors. Identification of the species was precisely done using several related keys and descriptions (Askew, 2004; Bartenev, 1913; Boudot, et al. 1990; Dijkstra, 2006; Dumont, 1974, 1991; Dumont & Heidari, 1996; Fraser, 1933; Schneider, 1986; Schröter, 2010; Schmidt, 1954; Skvortsov, 2010). For comparing details of three- dimensional structures such as terminal appendages, a microscope camera (Tucsen 3.1 MP) was used. Several photos from key characters of the species were taken with close- focus areas at the top as well as the bottom and then good images was stacked using Adobe Photoshop software (CS5).

All specimens were deposited in CBSU (Collection of Biology department of Shiraz University). Map of localities was prepared using GPS data (Using GPS visualizer website: www.gpsvisualizer.com). Terminology of wing venation and also genitalia follows Needham and Heywood (1929).

RESULTS

Totally 47 specimens belonging to 10 species, seven genera and four families were collected and identified. Most of the species were related to warm, semi-arid and arid habitats. These genera have also been mentioned in other checklists of desert's dragonflies (Suhling, et al., 2003; Borisov, 2006).

Suborder: Zygoptera

Family: Platycnemidae

Platycnemis dealbata (Selys in Selys & Hagen, 1850)

Material examined: Yazd, 6 ♂, 3 ♀, 7/1/2010; Taft, 3 ♂, 2 ♀, 6/30/2010; Mehriz, 4 ♂, 2 ♀, 7/2/2010.

This species is abundant in a wide range of habitats of Iran (Heidari and Dumont, 2002). We collected them from all three localities (Yazd, Taft, and Mehriz) at the opening of the Karizes between vegetations and peripheral regions and even in underground parts of Kariz entrance. Females often prefer marginal vegetation and males were denser in central part of the habitats. The

Table 1. Species found in Southwest of central desert of Iran in three localities.

Species	Yazd	Mehriz	Taft
Family: Platycnemididae			
<i>Platycnemis dealbata</i> (Selys in Selys & Hagen, 1850)	*	*	*
Family: Coenagrionidae			
<i>Ischnura intermedia</i> Dumont, 1974		*	
Family: Gomphidae			
<i>Onychogomphus forcipatus albotibialis</i> Schmidt, 1954		*	*
<i>Paragomphus lineatus</i> (Selys, 1850)		*	*
Family: Libellulidae			
<i>Orthetrum coerulescens anceps</i> (Schneider, 1845)		*	
<i>Orthetrum chrysostigma</i> (Burmeister, 1839)		*	
<i>Trithemis festiva</i> (Rambur, 1842)		*	*
<i>Trithemis annulata</i> (Palisot de Beauvois, 1805)	*	*	*
<i>Trithemis kirbyi</i> (Selys, 1891)		*	
<i>Crocothemis erythraea</i> (Brulle, 1832)	*	*	*

colors of collected females were paler than that of other females of *Platycnemis dealbata* of Iran and blue theme of males were more or less deeper.

Family: Coenagrionidae

Ischnura intermedia Dumont, 1974

Material examined: Mehriz, 2 ♂, 7/2/2010.

This species which described as a new species from south of central-east Anatolia (Turkey) by Dumont in 1974, is the closest species to *Ischnura forcipata* Morton (1907) and its name refers to intermediate position of this species between *I. pumilio* and *I. forcipata* [12, 14, 19, 21]. This species is poorly known. The distribution range of this species is still remaining unknown, but as Boudot (2009) stressed, it reaches from Turkey and Syria to Iran and Turkestan (Boudot et al. 2009).

This species is recorded for the first time from Iran although Dumont and Heidari mentioned its name in the dragonflies' checklist of Iran based on two specimens from Panchay river of Turkmenistan [Dumont & Borisov, 1995; Heidari, & Dumont, 2002]. The morphological characters of our specimens mostly are similar to *I. intermedia* described by Dumont (1974) and Schneider 1986, but few characters more or less is different.

Average measurements (mm): Total length of the male: 27-29; abdomen: 21-23 and hind-wing: 13-14.

Head: gena and frons greenish; postclypeus jet-black. Anteclypeus with black shallow suture. Rest of the head completely black; postocular spots non-circular, green- blue. Occipital part, yellow. (Fig.1).

Pronotum: mainly black, median lobes green with black strip. Anterior collar of prothorax and hind border of pronotum greenish, slightly upward, produced with thickened lower edge. (Fig. 2a, b).

Synthorax: lamina mesostigmalis, triangular; two small hooks at midposterior corner of pronotum curved upward to the hind margin. Level of these hooks slightly lower than upper rim (Fig. 2a). Median carina and humeral strip, black. Antehumerals, yellowish, about half of humeral strip. Meso-metapleural suture with black strip. Femora, green with black strip in exterior surface and spines, fore-tibia with narrow black strip; mid-tibia with brownish and narrower strip; no strip in hind-tibia.

Wings: Venation mostly brownish. Pterostigma (Pt), trapezoid, in fore-wings about three times of it at the hind wings, costal border about half of the basal border, with three color in fore-wings, black at base, blue flame pattern in middle and creamy at the top (this blue pattern exists in both preserved and dried specimens but has not been mentioned in any other descriptions), pterostigma in hind-wings, creamy with scatter light brown, parallelogram in shape, lesser than forewing (Fig. 3).

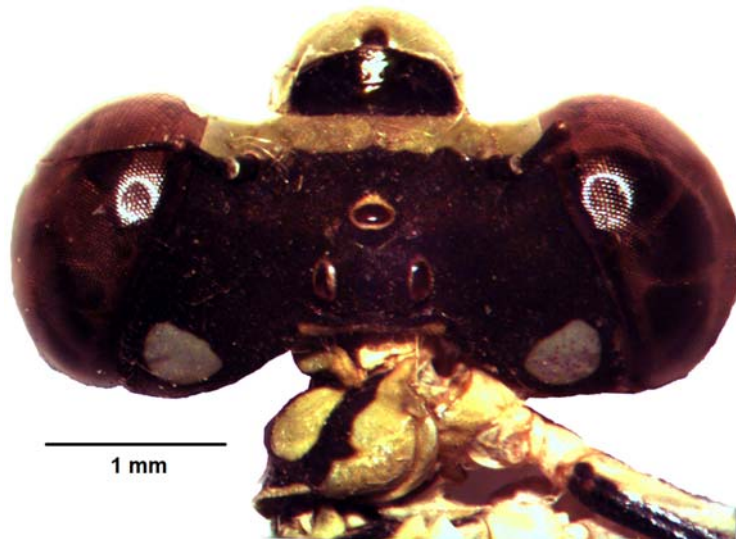


FIGURE 1. *Ischnura intermedia*, Head of male.

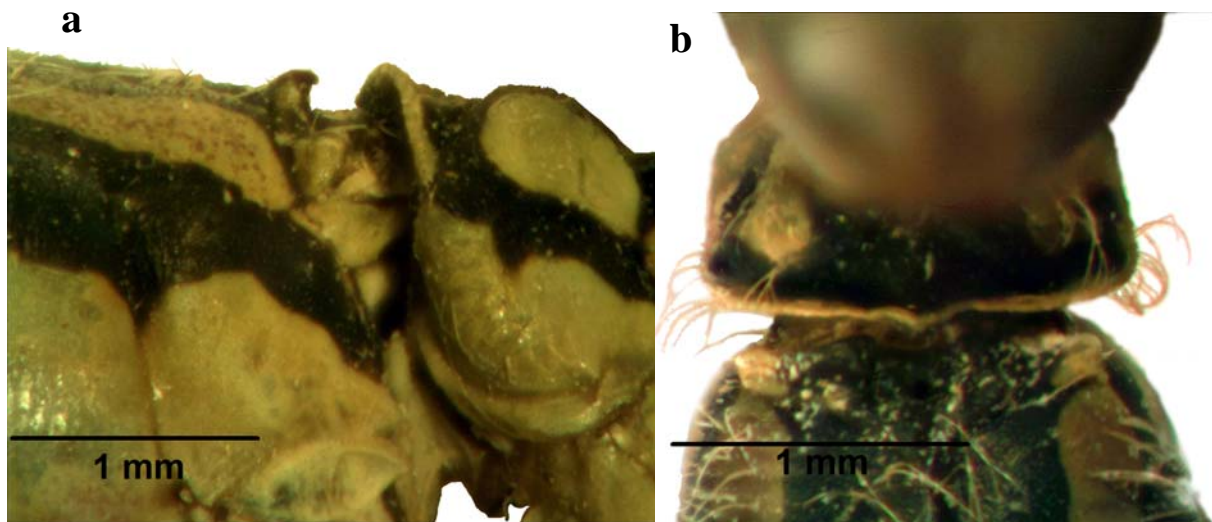


FIGURE 2. *Ischnura intermedia*, male, pronotum, lateral view (a), Dorsal view (b)

Abdomen: dorsal parts of S1-S7 jet-black, with triangular shape near to posterior border of each segment in lateral view, broader strip in S7, with a very narrow black band at beginning of S8, rest of S8 and S9 blue, S10 black in one-third of dorsal part, blue at the rest; ventral part of S1-S4 greenish, S5-S6 yellow (Fig. 4).

Appendages: inferior appendages (App. inf.), slightly shorter than superior appendages (App.sup.), tip of App. Inf., black, end of App. sup. with a median pointed denticle in upper and a dark lingual part in lower part, App. inf., triangular in lateral view and more or less parallel with App.sup., App.sup. black in exterior and brown in interior surface, inner teeth at the end of 1/3 lower part of App.sup, more difficult to see from dorsal view (Fig. 5).

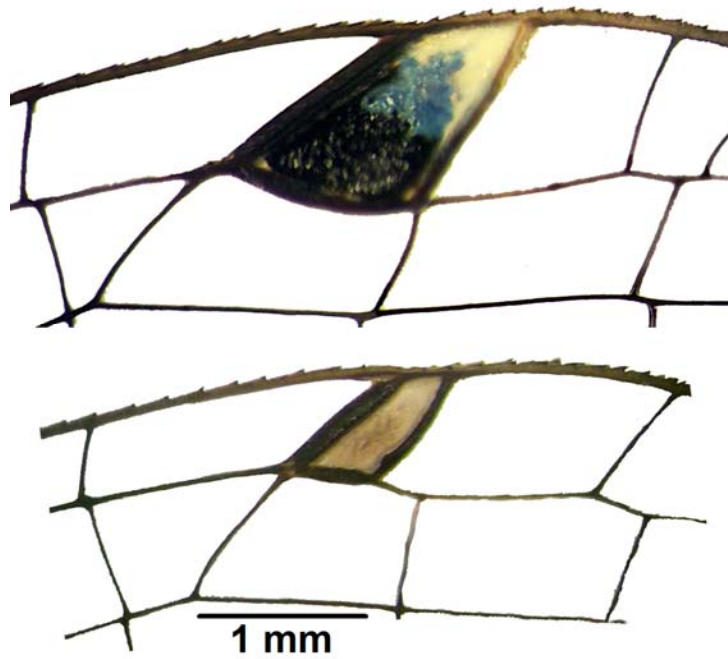


FIGURE 3. *Ischnura intermedia*, male, Pterostigma of forewing (Up) and hindwing (down).



Fig. 4. *Ischnura intermedia*, Male, abdomen.

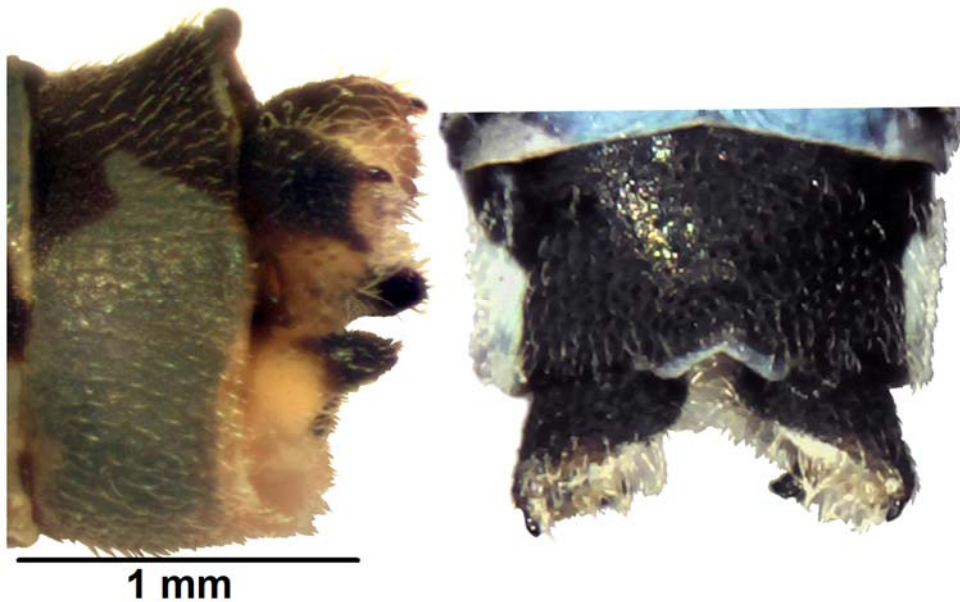


FIGURE 5. *Ischnura intermedia*, Male, appendages from lateral (a) and dorsal view (b).

Suborder: Anisoptera**Family: Gomphidae*****Onychogomphus forcipatus albotibialis* Schmidt, 1954**

Material examined: Taft, 2 ♂, 6/30/2010; Mehriz, 2 ♂, 7/2/2010.

This subspecies is often found in marginal areas or on dry vegetations near canals. Color patterns in darker parts are paler and background is more yellowish instead of greenish in comparison with other previously known specimens of this species from Iran; although shape, size and direction of protuberance in Inferior appendages (app. Inf.) is very close to other Iranian specimens.

***Paragomphus lineatus* (Selys, 1850)**

Material examined: Taft, 1 ♂. 6/30/2010; Mehriz, 2 ♂. 7/2/2010.

Habitats and some morphological features of this species are similar to *O. forcipatus albotibialis*; app. Inf. tip is shorter than European species. However, it is generally paler than other specimens that have been collected.

Family: Libellulidae***Orthetrum coerulescens anceps* (Schneider, 1845)**

Material examined: Mehriz, 2 ♂, 7/2/2010.

This subspecies with small size and thin abdomen, Blue-purple body and brown pterostigma were distinctly recognized at filed and frequently seen on peripheral and marginal vegetation areas around the canals or on stones or soil. Light brown colors of teneralis in females help them to hide and/or adapt to the environment.

***Orthetrum chrysostigma* (Burmeister, 1839)**

Material examined: Mehriz, 2 ♂, 7/2/2010.

This species is a common Afrotropical dragonfly that often found in warm localities. Males are simply recognized with waist abdomen near base. This species was rarely seen in perching position and often found on stones, rocks and soils near or on walls of Kariz canals. Like other species of this genus, light brown or dark creamy colors of females and teneralis protect them from predators.

***Trithemis festiva* (Rambur, 1842)**

Material examined: Taft, 2 ♂, 6/30/2010; Mehriz, 1 ♂, 7/2/2010.

This abundant species was also found in warm localities in both perching and grounding positions. Small body size and sloe color with dark brown patch on base of hind wings in fully adults clearly make this species recognizable.

***Trithemis annulata* (Palisot de Beauvois, 1805)**

Material examined: Yazd, 2 ♂. 7/1/2010. Taft, 2 ♂. 6/30/2010. Mehriz, 2 ♂. 7/2/2010.

This species with purple shining on body and metallic shining on frons as well as red veins on wings in fully adult males are easily distinguishable. They were often seen near temporary pools or artificial water reservoirs and streamlets far from main habitats or in vegetations; they prefer to perch in obelisk position.

***Trithemis kirbyi* (Selys, 1891)**

Material examined: Mehriz, 2 ♂, 7/2/2010.

Males and females of this species in some localities like Fars, Boushehr and Hormozgan provinces are homochromous. Body is orange or pale red. Wings with broad amber patch in base of both forewings and hindwings that provide an easy distinguishing features. The specimens were often seen in perching position on plants, stones and rocks near the canals.

***Crocothemis erythraea* (Brulle, 1832)**

Material examined: Yazd, 1 ♂, 7/1/2010; Taft, 1 ♂, 6/30/2010; Mehriz, 1 ♀, 7/2/2010.

This species is also abundant in Iran in most habitats. Broad and thick abdomen with bright red color and pale yellow pterostigma in fully adult males are distinct characters. Males were often found on vegetation near the canals and females far from these sites.

DISCUSSION

Yazd province has located in central part of Iran and distinctly isolated from other areas by great deserts in north and east and Zagros Mountain in west. Yazd is one of the driest provinces of Iran. The mean annual precipitation across this province is about 100 mm³ in year; this value is close to true deserts that show below 120 mm³ and in the recent years, it even reaches to extreme desert condition (Blow 70 mm³). Karizes are one of the most important water sources in this province. Such as Hassan-Abad's Kariz which is related to 700 years ago. This artificial water source has prepared a suitable environment for some aquatic invertebrates. Although, most of the water in Karizes passes through underground channels, in some places, the water will be exposed to the open air and flows on the ground surface. We captured our specimens in such locations (Fig. 6 and 7). Most species with suitable flying power for short distances found between main and temporary habitats such as gardens and parks' pools in the city of Yazd. The water of Hassan-Abad's Kariz transfers to Yazd with underground canals.

Air temperature in Taft is sensibly lower than Yazd and Mehriz and the water of Karizes is used for rural and gardening purposes. Various streamlets pass through the gardens and provide permanent or temporary streams and garden pools suitable for dragonflies' breeding. Water temperature is also distinctly cooler and minute insects' groups exist as prey. Open surfaces of water with no vegetation often are a good choice for some genera such as *Onychogomphus*, *Paragomphus* and *Orthetrum* that prefer resting on margins of water canals. Although most damselflies seem to prefer an area with vegetation but some *Platycnemis* damselflies frequently enter to underground parts of the Kariz. The larvae of this genus also exist in underground parts of the Kariz canals (Fig. 7). The origin of these species and that how they have been conserved and adapted to this kind of environment is unknown. It may be due to migration of some specimens to man-made water ditches from natural springs after drought. This fact may refer to described barriers around Yazd province such as Dashte Kavir and Lut deserts. With this new record, distribution range of *I. intermedia* is extended to central and southern parts of Iran. It seems that more populations of the species can be found in further searches.

A distinctive difference in lower part of app.sup. of *I. intermedia* was found between our specimens in comparison with described *I. intermedia* from Turkey and Turkmenistan. The size of the denticle-like protrusion of app.sup. that is similar to upper denticle differs from what previously recorded in *I. intermedia* (Fig. 5).

A comparison between described Turkish *I. intermedia* and Iranian ones showed that the situation of terminal appendages of these two populations a little differ in lateral side of app.sup. In our samples, there is a second lingua in connection to the denticle that has elongated in face of the denticle and seems like an opened mouth of a bird (Fig. 5). With more attention on body colour, one can clearly distinguish differences between Iranian *I. intermedia* and others in colour pattern of the body and blue color on pterostigma, which has not previously been mentioned in descriptions of the species in any papers. In addition, total body size and length of abdomen and wings are also larger.



Figure 6. Hassan-Abad's Kariz with chain of wells (from Google earth). Open surface of water (canal) and wells pattern.



Figure 7. Two different types of Kariz canal.

These differences may be due to geographic isolation of central localities of Iran because of extensive deserts at east and south, and Zagros and Alborz Mountains at west and north, respectively. As a result, at least central Iranian populations have been separated from northern populations which probably extended from Kopet Dagh Mountains to Anatolia.

It is not easy to talk about intermediate features or relatedness of our populations to northern populations based on present data. For more information about the origin and dispersal of this species in Iran, much more samplings along with morphological and molecular studies are necessary. Comparison between desert and non-desert dweller species can explain the history, dispersal scenario and the origin of these species. Future researches on more species from various deserts of Iran with genetic analysis of desert population of dragonflies can suggest their successful strategies against desert condition.

In the recent years, the low levels of rainfall in most parts of Iran on one hand and digging deep wells in arid and semi arid regions for agriculture without suitable management on the other hand, have caused Karizes have been involved in critical condition; therefore, some of historical Karizes have been dried. After the development of Kariz technology in many years ago, dragonflies gradually occupied water canals of Karizes, and presumably, after drying natural springs, survivance of the aquatic species was depended to the certain areas. Kariz systems for thousands of years have provided vital artificial places as essential habitats for many animals, therefore, destroying of these valuable habitats in the arid and semi arid regions will ruin all water- dependent animals.

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