

Some introduced vertebrate species to the Hashemite Kingdom of Jordan

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> Abstract

We report in this paper all the terrestrial and freshwater introduced species in Jordan. Eight species of mammals have been introduced to Jordan from other countries. One species is expanding its range of distribution (*Myocastor coypus*), while the others are confined to nature reserves or private farms, or released within the vicinity of nature reserves. Thirteen species of birds were introduced, either intentionally, escaped from cage or expanded their range. A total of 15 freshwater fish species were introduced into the inland of the Jordanian territories. The Common Carp, *Cyprinus carpio*, and *Oreochromis aureus* were the most introduced species from various origins. Of the introduced reptiles, the Red-eared Slider, *Trachemys scripta elegans*, was found in Azraq pools. The impact of invasive species on the local fauna was discussed. The native fresh water fishes were the most affected; whereas three endemic species are currently critically endangered due to introduction of invasive species into their habitats.

> Key words

Introduced species, Jordan, mammals, birds, reptiles, freshwater fishes.

Introduction

Jordan is located in the heart of the arid Middle East on the crossroad of three continents. Within the past 50 years, Jordan witnessed rapid changes in habitats, introduction of alien terrestrial and freshwater vertebrate species as well as other forms of environmental modifications (GCEP, 1998). Due to lack of understanding of the potential ill effects of introduced species to the local fauna, several species meant for captive breed-

ing, aquaculture production and as pet animals were deliberately or accidentally released. Some of these species were able to reproduce and establish populations in the wild.

At present many countries recognized the problem of introduced species to its local habitats and biodiversity (JESCHKE & STRAYER, 2005; ROLL *et al.*, 2008; LAIKRE *et al.*, 2010). Limited information on intro-

duced vertebrates (terrestrial and freshwater) in Jordan is available. Sketchy reports indicated historical records on the introduction of freshwater fishes to Azraq Oasis (NELSON, 1973; KRUPP & SCHNEIDER, 1989).

The aim of this study is to identify and document introduced non-native species to the Hashemite Kingdom of Jordan, their current distribution, and to discuss their potential threats to the native fauna, adapted to the local arid and semi-arid conditions. The drivers and consequences of species introductions and invasions have not been studied well in arid environments.

Materials and methods

This study is based on field data and observations obtained by the authors during the past 20 years while conducting field work in Jordan. Other data were extracted from published reports, papers, books and obscure literature. Communications with the Ministry of Agriculture, the Royal Society for the Conservation of Nature and other local agencies were executed to gather data regarding introduced species. Also, we extracted data from the Worldbirds data base on observations and records of bird watchers who visited Jordan.

Results

1. Mammals

Eight species of mammals have been introduced to Jordan from other countries (Table 1). Only one species, *Sus scrofa*, was relocated from the Jordan Valley to Wadi Al Dhulail area. At present, one species is expanding its range of distribution (*Myocastor coypus*), while the others are confined to nature reserves or private farms, or released within the vicinity of nature reserves.

a. Mammals released in nature with a current wide range of distribution

Worldwide, the Nutria (*Myocastor coypus*) has been introduced from its original habitats in South America to all continent except Australia and Antarctica (CARTER & LEONARD, 2002), and became a pest species, causing damage to water control structures, crops, and marsh systems and is considered a disease host. The nutria

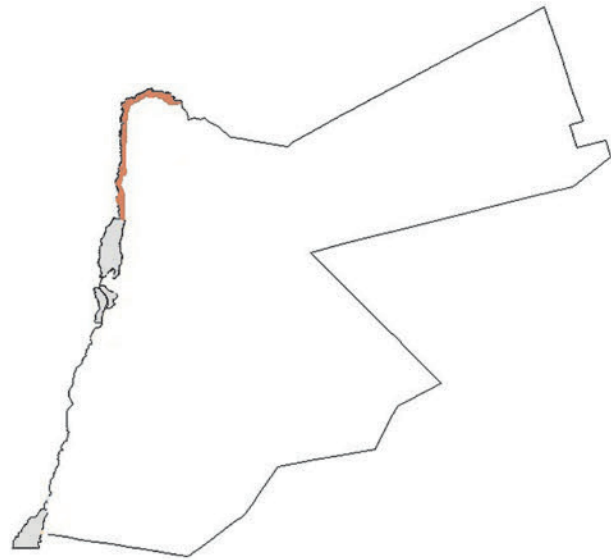


Fig. 1. Current distribution of *Myocastor coypus*.



Fig. 2. The Nutria, *Myocastor coypus*, collected from the mouth of the Dead Sea.

is the only species of introduced mammals known to occur in the major permanent water bodies of Jordan (AMR, 2000).

The Nutria was introduced into the area by Jewish fish farmers for fur production in the early 1950s from Chile (BODENHEIMER, 1958) and for economic reasons they were released in the River Jordan system (ROLL *et al.*, 2008). Also, it was introduced into fish ponds to control reeds, but proved to cause damage to fish pond dikes due to their burrowing behavior (MENDELSSOHN & YOM-TOV, 1999).

Now, it is common along the Jordan and Yarmouk rivers (fig. 1) and one specimen was found along Jarash creek in the mountains, which is a tributary of the Zarqa River and River Jordan. We located several populations along the Yarmouk River near Aqraba village, and many others along the River Jordan. A specimen was brought from the northern mouth of the Dead Sea (Fig. 2). ATALLAH (1978) reported on a specimen

Table 1. Summary table for introduced mammals to Jordan.

Species	Year(s) of introduction	Source	Current status
<i>Capra nubiana</i>	1989	San Diego Zoo	Released in Mujib Natural Reserve
<i>Capreolus capreolus</i>	1988	Turkish-Bulgarian border	Ajloun Forest Reserve
<i>Equus hemionus hemippus</i>	1983, 1986 and 1989	London, Montpellier Stuttgart and Zurich zoos	Shawmari Wildlife Reserve
<i>Gazella subgutturosa</i>	2009	Saudi Arabia	Shawmari Wildlife Reserve
<i>Herpestes ichneumon</i>	2005	Egypt	Confined to Birgish area
<i>Myocastor coypus</i>	1950s	Chile	Breeding in Jordan and Yarmouk rivers
<i>Oryx leucoryx</i>	1962	Oman, Kuwait, Saudi Arabia	Shawmari Wildlife Reserve
<i>Sciurus anomalus</i>	2005 and 2009	Syria	Dibeen Nature Reserve
<i>Sus scrofa</i>	2002	Jordan Valley	Private farm in Wadi Al Dhulail

caught in 1968 along the Jordan River, south of the Hula Lake.

b. Introduced mammals with confined distribution

The Egyptian Mongoose, *Herpestes ichneumon*, originating from Egypt, was intentionally introduced to Birgish area for snake control in 2005. Initially 5 individuals were bred in captivity; their offspring were released within the vicinity of this oak wooded area. So far, these animals are confined in the fenced part of this private reserve.

Shipments of confiscated Persian squirrels (*Sciurus anomalus*), originating from Syria were released in Dibeen Nature Reserve. This release took place in 2005 and 2009.

c. Relocation of native species

The Wild Boar, *Sus scrofa*, is a rather common species in the Jordan Valley and can reach as far as Dibeen Nature Reserve in the eastern Mountains (AMR, 2000). It was introduced to Azraq desert oasis around the beginning of the 20th century (NELSON, 1973), and perhaps also by the British Army that was located in Azraq for the purpose of hunting. At present, this animal was extirpated from the oasis and does not exist anymore. However, we located an in-captive herd consisting of more than 20 animals in a private farm in Wadi Al Dhulail that was brought from the Jordan Valley during 2002 (fig. 3A).

d. Other introduced large mammals in captivity

In 1988, two males and two females of the Roe Deer, *Capreolus capreolus*, originating from the Turkish-Bulgarian border were donated by the Turkish Government to the Royal Society for the Conservation

of Nature (fig. 3B). By 1995, 12 individuals were surviving in Ajloun Forest Reserve (QUMSIYEH *et al.*, 1996). On 19 January 2006, 26 individuals (11 males and 15 females) were released in the reserve, and occasionally, they were found to have wandered outside the reserve, where they used surrounding vineyards for feeding and resting (EID & ANANBEH, 2009).

A breeding population of the Arabian Oryx, *Oryx leucoryx*, was established at the Phoenix Zoo in Arizona, USA with animals collected from a trip to Oman in 1962 and donated animals from holdings in Kuwait, Saudi Arabia, and the London Zoo (Fig. 3C). This "World Herd" began to multiply and formed the nucleus to repopulate the desert. *Oryx* have been successfully reintroduced to Jordan in 1978 where a herd of about 70 lived in the fenced Shaumari Wildlife Reserve (QUMSIYEH *et al.*, 1996). The herd increased in number reaching 186 heads in 1995, causing marked mortality, thus in 1997, the herd's management began dispersing them to other Middle Eastern countries and to another nature reserve in Jordan. By February 2006, 43 *Oryx* remained at Shaumari (HARDING *et al.*, 2007). Some of the Shaumari animals were translocated to Wadi Rum Protected area in a fenced area.

In 1989, 20 specimens of the Nubian Ibex, *Capra nubiana*, were donated from San Diego Zoo and placed at Mujib Natural Reserve (fig. 3D). This reserve occupies 212 km² overlooking the Dead Sea. Two local animals collected from Karak and Tafila were mated with the herd. Now, the herd persists around the Dead Sea basin. The wild form of the Nubian Ibex is still found in the Dead Sea Mountains, Wadi Rum, around Dana Biosphere Reserve and Aqaba mountains.

In 1978, 10 *Gazella subgutturosa* individuals (one male and 9 females) were donated to The Royal Society for the Conservation of Nature (RSCN) by private individuals (fig. 3E). Their origin was not clarified. HARRISON claimed that these animals were hybrids between *G. subgutturosa marica* and *Gazella dorcas*. First births were recorded in 1980–1984 with a total number of 52. In 1990, the highest number of *G.*



Fig. 3. Introduced and relocated artiodactyls in Jordan. **A.** The Wild Boar, *Sus scrofa*, in Wadi Al Dhulail. **B.** the Roe Deer, *Capreolus capreolus*, in Ajloun Forest Reserve. **C.** the Arabian Oryx, *Oryx leucoryx*, in Shaumari Wildlife Reserve. **D.** The Nubian Ibex, *Capra nubiana* in Mujib Nature Reserve. **E.** *Gazella subgutturosa*, in Shaumari Wildlife Reserve. **F.** The Syrian Ass, *Equus hemionus hemippus*, in Shaumari Wildlife Reserve.

subgutturosa was recorded and reached 34 individuals. However, in 1990–1991 the herd declined sharply to 22 heads, until finally reached to 14 in 1994. The RSCN decided to exterminate this herd because of its unknown origin. In 2009, 20 individuals were brought from Al Talilah Nature Reserve, Syria. Their origin is from Saudi Arabia, however, doubts about the possibility of hybridization with a Sudan *G. subgutturosa* remains undetermined.

In 1983 two males and one female Syrian Ass, *Equus hemionus hemippus*, were brought to Shaumari Wildlife Reserve from London Zoo (fig. 3F). Later in 1986, additional male was brought from Montpellier Zoo, France. Due to deaths in this herd, only three

females lasted. In 1989, one male was donated by Stuttgart Zoo. Furthermore, one male and four females were added to the herd originating from Zurich Zoo. At present, the herd in this reserve is 27 individuals.

2. Birds

In this section we identified birds that became invasive due to human deliberate introduction and birds that expanded their range of distribution due to ecological change in land use. Thirteen species of birds were introduced, either intentionally, escaped from cage or expanded their range (Table 2).

Table 2. Summary table for introduced birds to Jordan.

Species	Year(s) of introduction	Source	Current status
<i>Acridotheres ginginianus</i>	2003	Cage escapees	Not breeding
<i>Acridotheres tristis</i>	2004	Cage escapees	Not breeding
<i>Agapornis roseicollis</i>	2010	Cage escapees	Not breeding
<i>Corvus splendens</i>	1976	India	Breeding and expanding
<i>Lonchura malabarica</i>	Unknown	Cage escapees	Breeding and expanding
<i>Oena capensis</i>	1980's	Unknown	Breeding and expanding
<i>Poephila guttata castanotis</i>	1990's	Cage escapees	Not breeding
<i>Psittacula krameri</i>	Reported since 1980	Cage escapees	Breeding
<i>Psittacus erithacus timneh</i>	2010	Cage escapees	Not breeding
<i>Pycnonotus leucogenys</i>	1990 and 1997	Iraq	Breeding in Azraq
<i>Rhodospiza obsoleta</i>	1976	Unknown	Breeding and expanding
<i>Streptopelia decaocto</i>	1979	Unknown	Breeding and expanding
<i>Streptopelia senegalensis</i>	Before 1900's	Brought by the Ottomans	Breeding and expanding

a. Introduced species by man

— The Palm Dove, *Streptopelia senegalensis*

The Palm Dove can be described as an invasive species since it spread very rapidly to most parts of Jordan following agricultural expansion and urbanization during the second half of the 20th century (fig. 4). The origin of this dove that first colonized Jordan remains not fully understood. Introduction of birds by the Ottomans (ROLL *et al.*, 2008) occurred in the region although a natural spread from Egypt/Arabia into Jordan via Aqaba cannot be ruled out. Local populations have mixed features of 2–3 different subspecies. Introductions by Ottomans were apparently more common in Palestine, from where this species may have spread into Jordan after 1950s, following a significant increase of population size in neighbouring countries, and following agricultural developments and increased urbanization in Jordan. Despite being now present in all urban areas in Jordan, this species is apparently not a native species. The Palm Dove is mainly distributed in Africa, parts of Arabia; now also in the Middle East north to Turkey and is considered as a tropical/subtropical species.

Although it was probably present in Aqaba and parts of the Jordan Valley since the beginning of 20th century, it was first recorded from Petra, Aqaba and Amman during 1977 (ANDREWS 1995, F. KHOURY, personal observations) in urban areas and other human settlements, thereafter rapid spread along the Jordan Valley and the western parts of Jordan. Soon after 1980 it rapidly expanded into urban areas, all types of settlements and farmland in all parts of Jordan including settlements in the eastern desert (e.g. Azraq, Safawi and Ruweished).

This species is common in gardens, farms with buildings or other human-made buildings including

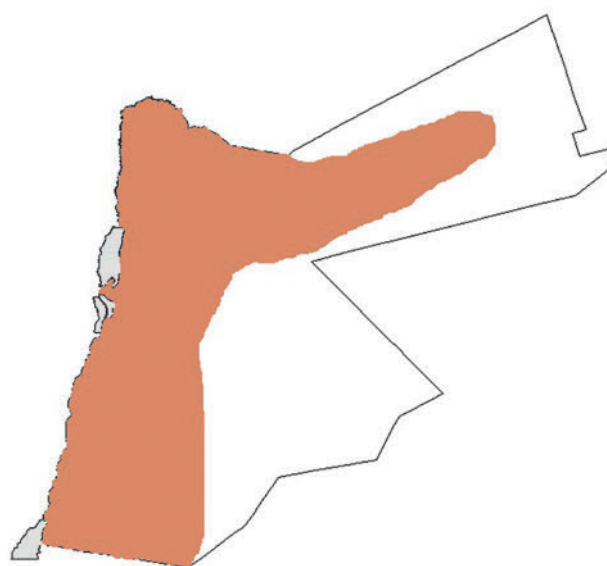


Fig. 4. Current distribution of the Palm Dove, *Streptopelia senegalensis*.

palm groves; it also occurs among cliffs in desert areas inhabited by Bedouins (e.g. Petra, Wadi Araba, Wadi Rum, Al-Dahek). Distribution in western Jordan is nearly continuous, however, sporadic or patchy in Sharrah highlands and the eastern desert. It is generally absent from most types of uninhabited natural habitats (e.g. open desert, semi-desert and steppe, and natural woodlands).

— Ring-necked Parakeet, *Psittacula krameri*

Feral populations have been established in Amman and elsewhere in the 1980s (WITTENBERG, 1988; HAYS, 1995). This is a recently introduced exotic species that has been able to establish localized feral populations in urban and agricultural areas, with very lim-



Fig. 5. Some introduced birds to Jordan. **A.** White-cheeked Bulbul, *Pynonotus leucogenys*, in Azraq. **B.** Bank Mynah, *Acridotheres ginginianus*. **C.** Indian House Crow, *Corvus splendens*. **D.** Collared Dove, *Streptopelia decaocto*. **E.** Namaqua Dove, *Oena capensis*.

ited invasive expansions into surrounding areas. Over 22,000 birds were imported into Jordan in 1987–1988 (RSCN data base). The escapees/released birds have lead to the simultaneous establishment of resident populations in various urbanized and agricultural areas in Jordan.

It was first recorded from Aqaba in 1979, Amman and Azraq/Shaumari area in 1987 (WITTENBERG, 1988; ANDREWS, 1995). Since 1990 to the present, numerous observations were made in Amman, Jordan Valley, Madaba, Irbid, Aqaba, Zarqa area, Azraq and Shaumari (Fig. 6), and probably elsewhere in vari-

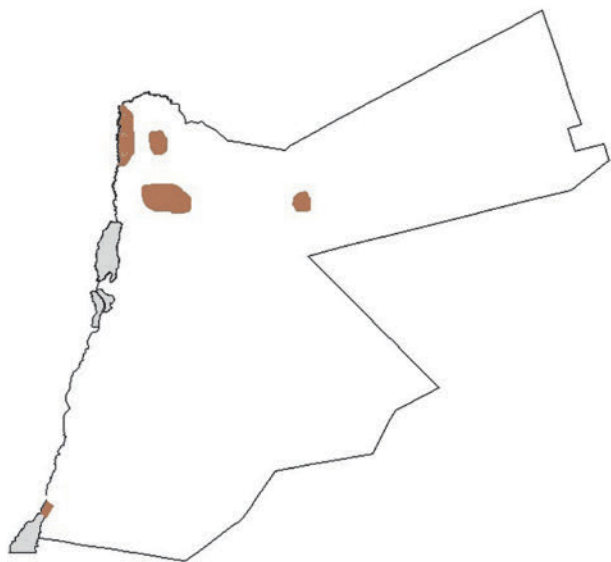


Fig. 6. Current distribution of the Ring-necked Parakeet, *Psittacula krameri*.

ous cities and agricultural areas in Jordan. The largest population is apparently in Amman and Aqaba, followed by Azraq. In Amman city, more than 100 birds were regularly spotted from late 1980s to 2000, after which a decrease was evident in Amman. Nests are rarely discovered in Jordan. One nest was found in a tree hole near Irbid during the 1990s (M. GHARAIBEH, personal communication). Population density, trends, distribution and behaviour are not yet studied.

— **White-cheeked Bulbul, *Pycnonotus leucogenys***

The White-cheeked Bulbul was first recorded during 1990 in Aqaba, and later in Azraq during 1997. These specimens were most likely cage escapees. In 1998, an illegal shipment of about 200 birds that was confiscated on the Iraqi borders was released in Azraq. Thereafter, a resident population became established at Azraq (Fig. 7). The current population is breeding mainly in farmland and orchards, however, the current population size is not known. In 2002, 16 birds including juveniles and many more in the following years were trapped in the Azraq wetland reserve. Other records of singles in Amman and Zarqa area (Hashemite University) were made during 1999–2004, but these populations (other than Azraq) did not become established.

The White-cheeked Bulbul is a cage bird that used to be imported during the 1980s and 1990s from Iraq and Syria. Before 1999, it was recorded as vagrant in Jordan, but also these birds were most probably escapees. This species has successfully colonized and spread throughout all parts of Azraq and surrounding farmland; a suitable environment was created by agricultural developments, and its niche was not oc-

cupied by any other species. The Spectacled Bulbul *Pycnonotus xanthopyrma* is a native resident in western Jordan where it inhabits a variety of habitats and apparently occupies the niche otherwise suitable for white-cheeked bulbul. The Spectacled Bulbul, native to western Jordan was never able to reach and colonize Azraq. Bulbuls avoid open areas without trees. They have short and rounded wings and are thus not suited for prolonged flights required to cross vast desert areas. This may be the reason why the White-cheeked bulbul is not able to invade other areas from Azraq, and also a possible reason why Spectacled Bulbul never colonized in Azraq.

The White-cheeked Bulbul is a subtropical bird known in hot climates in western Asia. It is often associated with human settlements in both rural and urban areas.

— **Bank Mynah, *Acridotheres ginginianus***

This bird occurs in tropical regions, and is held occasionally in cages as a pet. Four individuals were observed in Sweimeh in the Jordan Valley during 2003 and further four individuals were nesting in 2004. The nesting attempt was apparently unsuccessful and the species was not recorded later.

— **Common Mynah, *Acridotheres tristis***

A record of a group of eight Common Mynah at Kafrein in 2004 stays unconfirmed and could have concerned misidentified Bank Mynah (record submitted and rejected by Jordan Bird Records Committee). One further record was obtained from Azraq in 2005. Actually, the Common Mynah is more likely to invade the Jordan Valley in future because this bird is more often kept as cage bird and feral populations already became established and are spreading in neighbouring countries of the Middle East.

Despite of a breeding attempt in 2003 by Bank Mynahs, neither the Bank Mynah nor the Common Mynah were able to establish a feral population as a base for expansion in the Jordan Valley. Mynahs were not recorded after 2004, but due to the lack of bird-watchers visiting the Jordan Valley, data is considered insufficient. Both species of Mynahs occur in Southern Asia, mainly the Indian subcontinent.

— **Indian House Crow, *Corvus splendens***

Appeared first in the Gulf of Aqaba in 1976 (PAZ, 1987). It was most probably brought by ships from southern Arabia. It is present in Haql, on the Gulf of Aqaba in 1989 (M. JENNINGS, pers. comm.), close to the long standing population at Aqaba (Fig. 7).

The population apparently started to increase in 1980s–2000, reaching more than 300 birds; nesting is observed mostly in large trees within the town and along the coastal palm groves. Currently it nests also

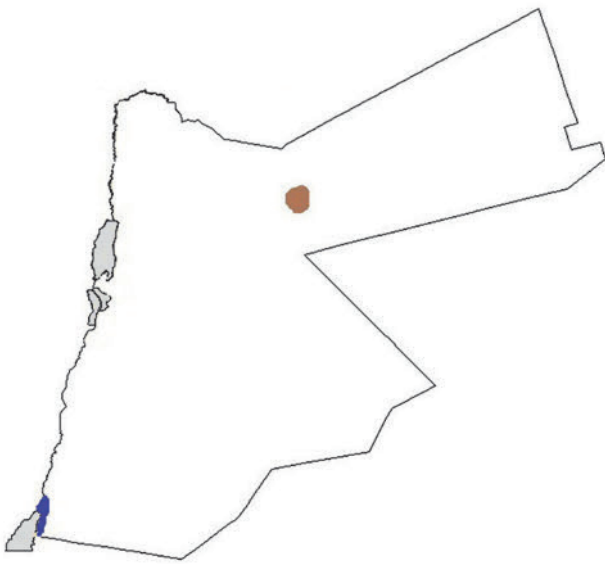


Fig. 7. Current distribution of the Indian House Crow, *Corvus splendens* (blue) and the White-cheeked Bulbul, *Pycnonotus leucogenys* (brown).

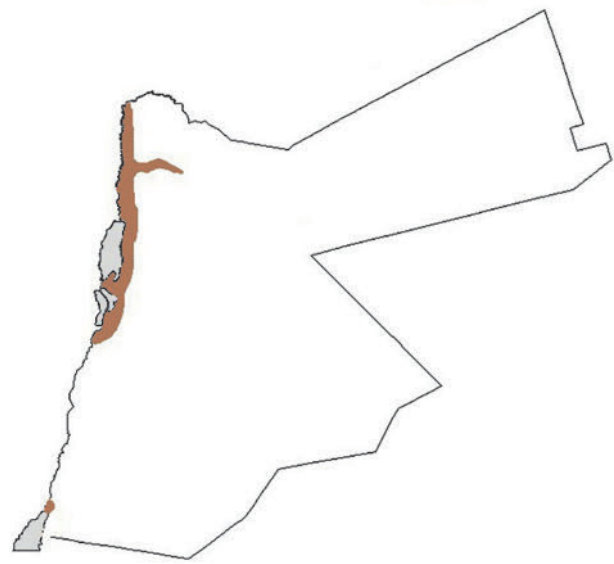


Fig. 8. Current distribution of the Indian Silverbill, *Lonchura malabarica*.

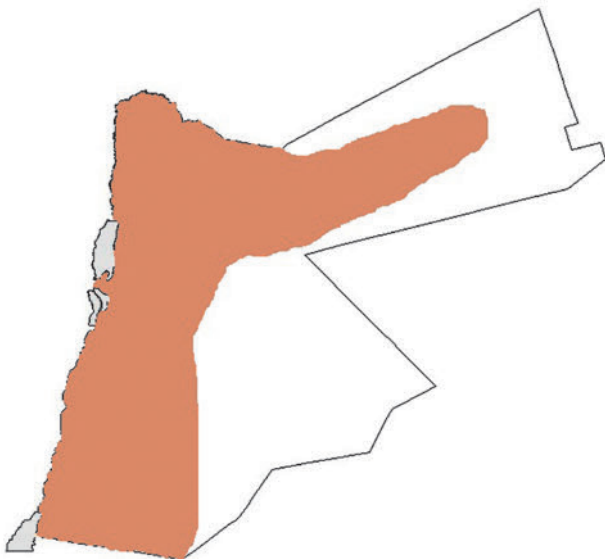


Fig. 9. Current distribution of the Collared Dove, *Streptopelia decaocto*.

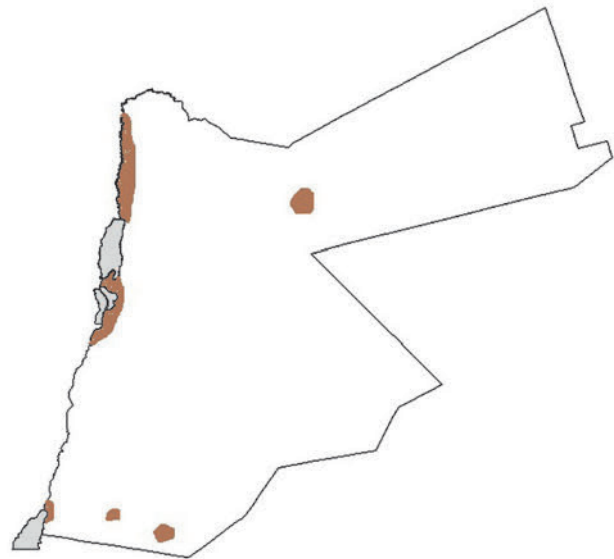


Fig. 10. Current distribution of the Namaqua Dove, *Oena capensis*.

at the northern outskirts of Aqaba, thus a northward invasion into the Jordan Valley is possible in the future. The birds often move between Aqaba, Eilat and neighbouring coastal towns at the borders to Saudi Arabia. The Indian House Crow was seen attacking pigeons and black-headed gulls in small groups of 3-5 individuals. It is considered a nuisance by many locals and a few campaigns have been conducted by the local authority to control the numbers in Aqaba city. Also, this crow was observed at Disi, near Wadi Rum (ANDREWS, 1995).

— Indian Silverbill, *Lonchura malabarica*

An introduced species through cage escapes. It breeds now in many areas in Jordan especially at the Jordan

valley near the Jordan River, along the Dead Sea shores at Fifa and also in Aqaba. This is a very common pet species, and is bred intensively in cages for trade.

This is the most invasive bird species in Jordan. It has been introduced/escaped for the first time in the 1980s, and started breeding and expanding along the Jordan Valley and its tributaries further east (e.g. Wadi Zarqa, As-Sukhna, Khirbet As-Samra Wadi Shueib and probably Wadi Bahhath (Fig. 8). It was recorded nesting in olive plantations near Khirbet As-Samra, and in native acacia and ziziphus trees in Ghor Assal and Fifa. Nesting activity was recorded between March and as late as November in the Jordan Valley, indicating a prolonged breeding season contributing to high reproductive and invasive abilities.

a. Alien species that expanded their range of distribution to Jordan without direct human interference

The following species may be added to the list of invasive species, they were not recorded as resident or breeding species prior to the 1970s, and are now locally common in disturbed ecosystems. These are set apart from other bird species that merely expanded their breeding range within Jordan to the east due to agricultural developments and were always part of the native avifauna in natural habitats in western Jordan.

— **Collared Dove, *Streptopelia decaocto***

The Collared Dove may have occurred as scarce species in few locations in the western parts of Jordan for a long time before it was officially recorded in 1979 (ANDREWS, 1995). This species can be considered invasive in Jordan since it is expanding its range in Jordan and many other parts of Asia and Europe, and the local populations and distribution increased significantly following agricultural expansion (fig. 9), in the second half of the 20th century (as in Palm Dove). Now it inhabits all types of farmlands with irrigation in all parts of Jordan including deserts. It is less attracted to and often missing from mountain areas with traditional, rain-fed farming.

Before its expansion, this bird was probably a localized and scarce resident in the northern parts of the Jordan Valley, or it invaded Jordan from neighbouring parts sometime in the last century. At first it was restricted to subtropical, very warm climate, but now it has invaded all regions and climates within Jordan, following agriculture expansion and the presence of waters and trees even in remote desert areas. As it nests in trees or high shrubs, it cannot reproduce or survive longer in areas devoid of such vegetation. In the eastern desert, it occurs at most remote artesian wells if a few trees exist.

It was first documented in Jordan in 1979 from unknown site (ANDREWS, 1995). In the 1980s, hunters reported this species in Jordan Valley and agricultural areas of northern Jordan south to Al-Qastal (south of Amman). At present, it is a very common species in the Jordan Valley and along rift margins where it also invaded riparian vegetation and Tamarisks along the river Jordan (KHOURY, 2001). In Wadi Araba, it is now associated with acacia trees, and occasionally high *Haloxylon persicum* shrubs, but it is more common near and within farmland (KHOURY & AL-SHAMLIH, 2006). It is also common in open *Quercus aegilops* stands in warm Mediterranean climates and all types of tree plantations, including olive plantations in arid areas.

— **Namaqua Dove, *Oena capensis***

This species may also be considered invasive as it is

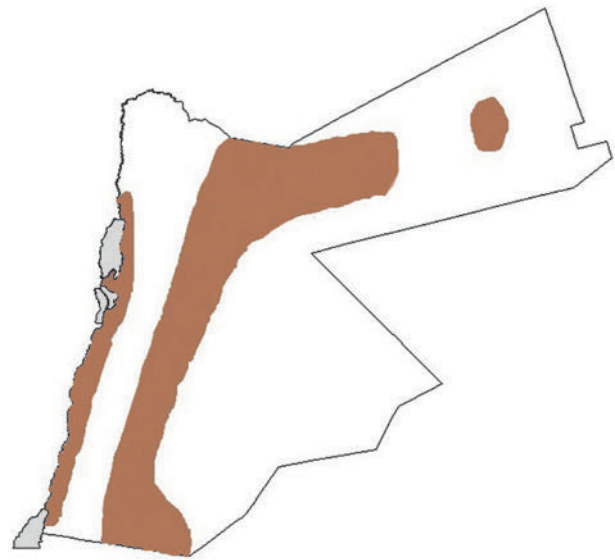


Fig. 11. Current distribution of the Desert Finch, *Rhodospiza obsoleta*

expanding its range along the Jordan Valley very rapidly, following agricultural expansion. The Namaqua Dove has been very successful in colonizing most parts of the Jordan Valley during the last 2 decades without the involvement of introductions (Fig.10). It is often recorded in all parts of the Jordan Valley from Fifa north to Wadi Ar Rayyan in all seasons. Daily counts usually exceeded five birds in the southern and central Jordan Valley during a survey conducted in 2005 (KHOURY *et al.*, 2006). One group of 17, including 8–10 juveniles, was located in the Karamah area on 27 July 2005. KHOURY (1996) provides the first evidence of its breeding in Azraq.

Early records go back to 1966 in Azraq, Shaumari in 1985, Ghawr es Safi in 1986, Disi in 1986 and Aqaba in 1989. Further numerous records after 1996 include the Jordan Valley, Aqaba, Disi, Wadi Zarqa–Dhleil, Qasr Amra and Azraq. These records also involve migrant birds recorded in non-breeding habitats during spring migration.

Because it is also regularly recorded in winter in the Jordan Valley and at Disi, it may have established a resident population in the Jordan Valley and Disi, whereas at Azraq it appears only from April to early September. At Azraq and many other parts of the Middle East this species behaves as a summer visitor, and migrant species.

The species occupies mainly open salt marsh habitats scattered with *Tamarix*, saltbush *Atriplex* sp. or sea-blight *Suaeda* shrubs, usually near agriculture and occasionally at field-edges in agricultural habitats.

— **Desert Finch, *Rhodospiza obsoleta***

Perhaps this species used to breed in Jordan since the 1970s, earlier known only as winter visitor (ANDREWS,

1995; SHIRIHAI, 1996). Recent expansion into Aqaba and many parts of the desert is evident where there are irrigated olive plantations and farmland with high trees (KHOURY *et al.*, 2009). This is not the only species that has benefited from agricultural farmland, but it is one of very few species that have actually started breeding and expanding into Jordan due to agricultural developments in the deserts (fig. 11).

First recorded in Azraq 1976 (ANDREWS, 1995). After 1990, several observations were made at Aqaba, Disi, Wadi Araba, Sweimeh, Safawi, Zarqa and Dhleil areas, Ma'an, and Shaumari.

c. Other occasional sightings of alien birds

One African Grey Parrot, *Psittacus erithacus timneh*, was seen during September 2010 at Al Jubyha, near Amman (HAMIDAN, personal observation). Many records of escaped or released Zebra finches and lovebirds mainly in Amman have not led to the establishment of feral populations.

3. Freshwater Fishes

We were able to document the introduction of 15 freshwater fish species into the inland of the Jordanian territories (Table 3). The Common Carp, *Cyprinus carpio*, and the Blue Belly Tilapia, *Oreochromis aureus* were the most introduced species from various origins. Twenty-two fish farms stocking both species are operating in Jordan, 13 are located in the Jordan Valley.

KRUPP & SCHNEIDER (1989) listed 28 species that have been introduced to the catchment basin of the Jordan River. At least 10 of these species were able to reproduce within the Jordan River catchment (KRUPP & SCHNEIDER, 1989), while the others were not able to survive and are considered to be extinct or not reproducing in the wild. In the Jordan Valley, many private fish stocking enterprises were established within the vicinity of the Jordan River. Introduced species include *C. carpio*, *Clarias gariepinus*, *Oreochromis aureus*, *Oreochromis niloticus* and *Mugil cephalus*. The Common Carp, *C. carpio* and the Nile Tilapia, *Oreochromis mossambicus* are the most common stocked species.

Five species have been introduced to Azraq (*Acanthobrama lissneri*, *Cyprinus carpio*, *Clarias gariepinus*, *Oreochromis aureus* and *Tilapia zillii*). At present, only two *Cyprinus carpio* samples were collected during the past 12 years. However, it was introduced to many water bodies in the eastern desert (i.e.

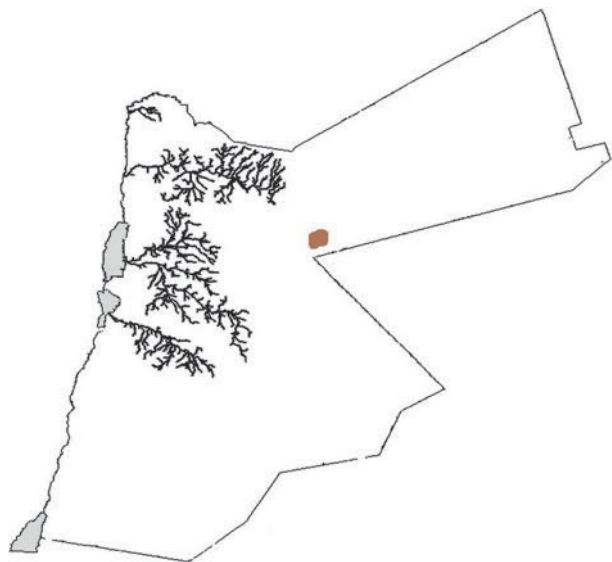


Fig. 12. Current distribution of *Acanthobrama lissneri*.

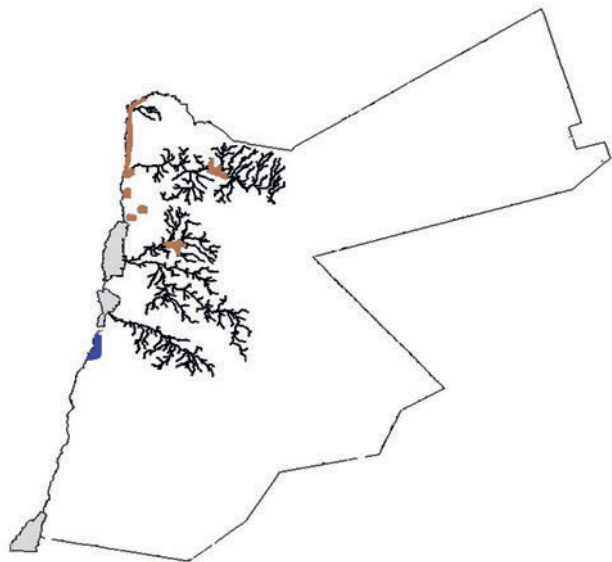


Fig. 13. Current distribution of *Clarias gariepinus* (brown) and *Gambusia affinis* (blue).

Dabadeb and Burqu). The Catfish, *Clarias gariepinus*, was last record in 2000 at Azraq Oasis. *Acanthobrama lissneri* is still breeding in Azraq pools (Fig. 12). The Catfish occurs in the Jordan Valley system, however, it is not clear if and where exactly the Catfish is considered native or introduced.

Clarias gariepinus is the most common species in King Talal, Sharhabeel Dam (=Ziglab Dam), Karameh, Wadi Al Arab dams. All these populations may originate from the Jordan River Basin (Fig. 13). The Ziglab irrigation reservoir was normally stocked with 700 carp and 100 tilapia fingerlings in 1966 (APOSTOLSKI, 1967; FAO, 1973).

Cyprinus carpio is one of the most wide spread introduced species. It was found in several dams in the highlands as well as in desert dams (Fig. 14).

Table 3. Summary table for introduced freshwater fishes to Jordan.

Species	Purpose of introduction	Source	Place of introduction and date	Current status	Authority and references
Family Mugilidae					
<i>Mugil cephalus</i>	Aquaculture	Egypt	Al Zour and Abu Obiedah-2003	Unknown	MOA
Family Cyprinidae					
<i>Acanthobrama lissneri</i>	Side collection	Came along when Cichlids where introduced	Azraq	Breeding	Observed
<i>Barbus canis</i>	Aquaculture	Introduced by the Ottomans, during the first decade of the 20 th century	Azraq	Last recorded in 1990	NELSON (1973)
<i>Ctenopharyngodon idella</i>	Aquaculture	Bulgaria	? 1985	Not breeding	
<i>Cyprinus carpio</i>	Aquaculture	Syria	Azraq-1965	Unknown	Observed
	Aquaculture	Syria	Wadi Al Yabis-1972	Unknown	MOA
	Aquaculture	Unknown	Wadi Ziglab-1971	Unknown	ALIKUNHI, 1973
	Aquaculture	Unknown	Al Sukhnah 1967	Unknown	MOA
	Aquaculture	Unknown	Introduced to all water bodies in the eastern desert such as Burqu'	Breeding	Observed
	Aquaculture	Local breed	Al Mujib Dam-2009	Breeding	Observed
<i>Hypophthalmichthys molitrix</i>	Aquaculture	Bulgaria 1985		Not breeding	
Family Clariidae					
<i>Clarias gariepinus</i>	Aquaculture	Presumed to be brought from the Jordan Valley	Azraq	Not breeding. last record in 2000	KRUPP & SCHNEIDER (1989), Observed
		Unknown origin	King Talal Dam-1970 Wadi Al Arab Dam Karamah Dam	Breeding	Observed
Family Salmonidae					
<i>Oncorhynchus mykiss</i>	Aquaculture	Unknown	Marsa'-1986 Jordan River	Not breeding	MOA
Family Poeciliidae					
<i>Gambusia affinis</i>	Aquaculture	Unknown	Fifa-2010	Breeding	Observed
<i>Poecilia reticulata</i>	Ornament	Thought to be released by fish aquaria owners, used as Aquarium fish farm	Al Qenyah	Breeding since 10 years ago	Observed
Family Cichlidae					
<i>Oreochromis aureus</i>	Aquaculture	Jordan Valley, Ottomans? Al Karmahe dam	Azraq	Breeding	KRUPP & SCHNEIDER (1989)
			Al Mujib Dam Ain Al Haditha Fifa	Breeding	Observations and collection

Table 3. Summary table for introduced freshwater fishes to Jordan.

Species	Purpose of introduction	Source	Place of introduction and date	Current status	Authority and references
Family Cichlidae					
<i>Oreochromis mossambicus</i>	Aquaculture	USA	Azraq-1983	Not breeding	Observed
	Aquaculture	Thailand	Al Mnasheyah-1984 South Shounah-1985	Unknown Breeding	
<i>Oreochromis niloticus</i>	Aquaculture	Egypt	Al Kafraïn-2000	Not breeding in nature, confined in fish farms	MOA
<i>Tilapia zillii</i>	Aquaculture	Lake Tiberius, first decade of the 20 th century	Azraq	Breeding	NELSON (1973)

**Fig. 14.** Current distribution of *Cyprinus carpio*.**Fig. 15.** Current distribution of *Oreochromis aureus*.

Oreochromis aureus (fig. 15) has the highest impact on local freshwater fishes, especially on the endemic species *Aphanius sirhani* and *Garra ghorensis*, and the endemic subspecies *Aphanius dispar richardsoni*.

Detailed studies on the impact of cichlids especially *O. aureus* and *T. zillii* (fig. 16) on the endemic *A. sirhani* in Azraq wetland showed that there is a high competition for food and breeding grounds. Predation was also proved for eggs, fry, and juveniles (HAMIDAN, 2004).

Oreochromis aureus was released by the Ministry of Agriculture in water courses in Ghor Al Haditha, the type locality of the endemic, *Garra ghorensis*.

In this locality, fry of *G. ghorensis* were totally absent in samples taken regularly during the breeding season of year 2011, comparing with aquaria stock from the same origin collected a head of the breeding season in November 2010. In addition, population structure of the endemic Cyprinid was observed disturbed having only old specimens (more than 15 cm SL) with very few young of year fishes.

In the brackish water of Fifa Protected Area and Ein Abata, and comparing with field observation made in 2002 the endemic subspecies of killifish, *A. dispar richardsoni*, was abundant with no *O. aureus* introduction. However, recent field observations assured the habitat modification, and introduction of *O. aureus*



Fig. 16. A. *Cyprinus carpio* from Azraq pools. B. *Tilapia zillii* from Azraq pools.



Fig. 17. Current distribution of *Tilapia zillii*.



Fig. 18. Current distribution of *Poecilia reticulata*.

and *Gambusia affinis* (Fig. 13) caused the population of the endemic subspecies to be declined drastically, with only two specimens collected against large numbers of *O. aureus* and *G. affinis*.

A high population of *Poecilia reticulata* was located in the upper reaches of the Zarqa River at Al Quanya. Aquarium fish farm was established in the main course of the Zarqa River and the guppy could be observed by the thousands. However, we never located this fish in other parts of the river course.

4. Reptiles

We have a single record of the Red-eared Slider, *Trachemys scripta elegans*, from the pools of Azraq Oasis during 2004 (fig. 19). This turtle is found in pet shops in Amman and considered by far as one of the most popular pet species.

The Rough-tail Gecko, *Cyrtopodion scabrum*, was recorded from several newly established settlements

in the Jordanian desert including Safawi. These records represent local introduction of this species in desert habitats.

In 2001, a load of *Natrix tessellata* originating from Syria of over 100 specimens was released in the Zarqa River before obtaining permission. This load includes both the regular form and the melanistic *N. tessellata*. Eight individuals of the spur-thighed tortoise, *Testudo graeca*, from Syria were released in Dibe'en Nature Reserve in 2007.

More than five Middle-Eastern Spur-thigh tortoises, *Testudo graeca terrestris*, were found in Azraq Nature Reserve during 2009. These animals are believed to be released by visitors. The origin of these animals remains unknown, and perhaps they originated from the mountainous areas of Jordan or from sold animals that are usually brought from Syria. Azraq Nature Reserve does not naturally harbour the Middle-Eastern Spur-thigh Tortoise, since it is a dry area.

Discussion

Of the 100 species listed as the worst alien species (FLOWE *et al.*, 2000), at least three are known to have been introduced to Jordan; including the Common Carp, *Cyprinus carpio*, Red-eared Slider, *Trachemys scripta elegans*, and the Nutria, *Myocastor coypus*.

Six introduced bird species have been recorded so far in Jordan, five of which were definitely able to establish free-living and reproducing populations; the most invasive bird species include the Palm Dove inhabiting most urbanized areas in Jordan, and the Indian Silver bill, which is widely distributed in the Jordan Valley, along Wadi Zarqa, and in Aqaba. The Palm Dove is believed to have spread in the Middle East in the beginning of the 16th century (HENGEVELD & VAN DEN BOSCH, 1991). The Indian Silverbill is restricted to low-lying warm areas with trees and water, always at or close to agriculture. Most introduced and invasive bird species in Jordan are of tropical and sub-tropical origin and thus most successful in warm-hot regions of Jordan where winter temperatures are usually above freezing point, i.e. along the Rift Valley. Similar findings were reported by ROLL *et al.* (2008) in the Jordan Valley. They reported 14 non-indigenous birds are established locally and definitely reproducing in nature. Two non-indigenous birds are currently increasing in number and spreading to new localities (*S. senegalensis*, and *L. malabarica*). Others have localized ranges (i.e. *P. krameri* and *O. capensis*).

The spatial pattern of expansion varies according to species. With two exceptions (White-cheeked bulbul and Desert Finch), there is generally an expansion



Fig. 19. The Red-eared Slider, *Trachemys scripta elegans*, found in Azraq pools.

from west to east. The Indian Silverbill apparently expanded in all directions starting from the Jordan Valley area north of the Dead Sea. A similar expansion is expected to happen in case one of the Mynah species manages to establish a sustainable, viable population in the Jordan Valley. For the Namaqua Dove and the Indian House Crow, the expansion is currently occurring or expected to occur in south – north direction along the Rift Valley. So far, no direct impacts are known due to the range expansions of the Collared Dove, *Streptopelia decaocto*, and the Namaqua Dove, *Oena capensis*. There is no evidence of competition with the local breeding populations of the Turtle Dove. On the other hand, if the populations of Bank Mynah become established, it may invade the Jordan Valley and – breeding in holes – affect there some of the native hole-nesting species (e.g. Bee-eaters, Roller, Pied Kingfisher and Hoopoe). Mynahs are omnivorous and they readily devour fruits, thus they may have an impact on the local crops and economy of farmers.

The Indian Crow population in Aqaba is affecting other birds. Predation on other birds such as doves was observed. The Indian House Crow has successfully colonized the port city of Aqaba and is expanding

along with the rapid expansion of the city itself; birds and nests can be seen now at the northern borders of the city and at many locations along the southern coast until the borders with Saudi Arabia. It is thus expected to invade Wadi Araba and reach even the Dead Sea if Wadi Araba becomes developed for agriculture and other projects. In addition to being a nuisance and possibly causing health problems (may transmit gastrointestinal diseases to humans) in the city of Aqaba, this bird is generally known to be a nest predator, thus affecting the reproductive success of other bird species. Birds have been observed once attacking laughing gulls along the coast in Aqaba and apparently „stealing“ food from them. In Aden, Yemen, it can create problems for various sectors, including natural biodiversity, human health, tourism, infrastructure, and general development (SULIMAN *et al.*, 2011).

Invasive species usually reproduce rapidly in disturbed ecosystems and in urbanized and agricultural areas, where food and water are present nearly all year round. The records of nesting Indian Silver bills in Jordan from March to November indicate an extended breeding season permitting more than two broods per year.

As for introduced mammals, we can consider *M. coypus* as the main invasive species within the riparian habitats of Jordan. By now, it occurs along the Jordan and Yarmouk rivers, with penetration along the Zarka River. This species is now wide spread in many parts of the world and considered as one of the most invasive species (ALIEV, 1967; FLOWE *et al.*, 2000). This rodent has been introduced to every continent except Antarctica and Australia. In regions with mild winters and sufficient wetland habitat, eradication has seldom been successful (CARTER & LEONARD, 2001). Nutria feeds primarily on marsh vegetation that extends above the waterline, causing extensive damage to the ecosystem. Nutria feeds on wetland vegetation and consumes 25% of their body weight daily (LEBLANC, 1994). This perhaps will indirectly affect other riparian species inhabiting the area such as the Common otter and the Jungle Cat.

Large mammals kept for captive breeding constitute the major form of introduced mammals. At present, the Nubian Ibex, *C. nubiana* held at Mujib Nature Reserve for many years to reproduce, was released in the wild some five years ago. Certainly by now, the introduced individuals are interbreeding with the local stock. Non-indigenous species can bring about extinction of native flora and fauna by genetic hybridization and introgression either through purposeful introduction by humans or through habitat modification, bringing previously isolated species into contact (RHYMER & SIMBERLOFF, 1996).

Introduction of freshwater fishes into the various freshwater habitats poses a major ecological problem

in Jordan. This small country enjoys the presence of endemic species (*A. sirhani* and *G. ghorensis*) and endemic subspecies (*A. dispar richardsoni*) located in fragile habitats. At present, stocking of invasive species such as *T. zillii*, *G. affinis* and *O. aureus* is taking place in the habitat of these native species. Due to lack of knowledge and understanding the impact of the introduced on the native species, none of these introduction took the importance of these native endemic species into consideration. Indeed, *A. sirhani* came to the verge of extinction in Azraq desert oasis (HAMIDAN, 2002). This matter should be addressed by the Department of Animal Production, Ministry of Agriculture. All introduction and stocking activities in the freshwater bodies in Jordan should be regulated and monitored.

Indeed, invasive species are causing remarkable changes in ecological systems worldwide, and certainly having profound effects on local communities and their ecosystems (GUREVITCH & PADILLA, 2004).

In Palestine, ten species of introduced freshwater fishes are currently reproducing in the wild (BENTUVIA, 1981; ROLL *et al.*, 2007). Dangers of restocking and introduction of alien species include hybridization and formation of single-line strains into native systems. Hybrids of the native cichlid species escape from fish ponds into Lake Kinneret and other locations. In Spain, 25 species of introduced freshwater fishes are established in various freshwater habitats. It is assumed that competition with native species is certain to occur, however with no substantial evidences (ELVIRA & ALMODÓVAR, 2001).

In accordance with the IUCN guidelines for the placement of confiscated animals (IUCN, 2002), more responsible decision should be employed before releasing confiscated animals in the wild. These guidelines suggest three options; maintain the animals in captivity for the remainder of their natural lives, return the animals to original habitat in the wild or euthanize the animals.

Introduction of invasive species to Jordan should be regulated and controlled by the decision makers in the Ministry of Agriculture in collaboration with authoritative agencies in Jordan (i.e. Royal Society for the Conservation of Nature) for scientific opinion and advice.

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