Alien species recorded in the United Arab Emirates: an initial list of terrestrial and freshwater species

Pritpal Soorae 1, Salim Javed 2, Shaikha Al Dhaheri 3, Majid Al Qassimi 4, Maher Kabshawi 5, Anitha Saji 6, Shahid Khan 7, Sabitha Sakkir 8, Rashed Al Zaabi 9, Shakeel Ahmed 10, Junid N. Shah 11 & Ahmed Ali 12

1–12 Terrestrial Biodiversity Sector, Environment Agency-ABU DHABI, P.O. Box 45553, Abu Dhabi, UAE

Abstract: Little is documented on the alien terrestrial and freshwater species in the United Arab Emirates. To address this, an assessment of terrestrial and freshwater alien species was conducted using various techniques such as a questionnaire, fieldwork data, networking with relevant people, and a detailed literature review. The results of the initial assessment show that there are 146 alien species recorded in the following seven major taxonomic groups: invertebrates 49 species, freshwater fish five species, amphibian one species, reptiles six species, birds 71 species, mammals six species and plants eight species. To inform decision makers a full list of the 146 species identified in this assessment is presented.

Keywords: Alien species, invertebrates, United Arab Emirates, vertebrates and plants.
INTRODUCTION

The United Arab Emirates (UAE) is a federation of seven emirates: Abu Dhabi, Dubai, Sharjah, Ajman, Umm Al Quwain, Ras Al Khaimah and Fujairah that altogether cover an area of approximately 89,000 km² (which includes offshore islands). The UAE is located in the northern part of the Arabian Peninsula and is bordered to the west and south by Saudi Arabia, Oman to the east and the Arabian Gulf to the north. UAE’s climate can be described as hot and dry throughout most of the year, and according to the UNEP classification of dry lands is regarded as hyper arid (Middleton & Thomas 1997). The UAE is a unique case in that its harsh hyper arid climate itself poses a challenge for the survival and establishment of alien species, which are found to be limited mainly to degraded and transformed (e.g., urban) habitats.

Consequently, a project was initiated by the Environment Agency ABU DHABI (EAD) to conduct an assessment of terrestrial and freshwater alien species within the UAE. This was considered an initial step to document the types of species that are non-native to the UAE and which may pose a high risk to the natural ecosystem if they become established. A sub-regional workshop for western Asia and northern Africa to address alien species and to achieve the Aichi Biodiversity Target 9 (By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment) was held in the UAE in February 2013. This workshop was organized by the Ministry of Environment and Water (which has a federal level mandate covering all seven emirates) to start addressing the issues of invasive alien species (IAS) at a sub-regional level. Within a regulatory framework, management of alien species is required as the UAE is a signatory to the Convention on Biological Diversity (CBD) as per Article 8—In situ Conservation, Part H—Prevent the introduction of, control or eradicate those alien species, which threaten ecosystems, habitats, or species.

Hence, this paper presents an initial list of known terrestrial and freshwater alien species in the UAE, with the aim to present this knowledge in one list so that any future efforts can be based upon this baseline list shown in Appendix 1.

METHODS

The alien species knowledge in the UAE is dispersed and hence a multi-pronged approach was employed to collect data. The methods used were a detailed questionnaire and literature review to initially gauge the knowledge of alien species within the UAE. The EAD conducts biodiversity surveys in Abu Dhabi Emirate and these surveys also collect information on non-native species that are encountered. The EAD is also the UAE’s CITES Scientific Authority and has long-term data on confiscated species within the UAE mainly CITES listed species and some of these are collected from the wild.

Questionnaire and literature review

We initially conducted an extensive literature search to collect information on alien species recorded within the UAE. This literature search was focused on the years 1993–2011 (not many data sources were found prior to the early 1990s) and used the following search terms: UAE, invasive, exotic, non-native species. This review provided a baseline level of valuable information from various publications and provided a starting point for gathering information on alien species. This information was then built upon by using a questionnaire survey. Conducting a literature review also provided valuable information as a starting point.

A questionnaire is a useful tool as it gives you an idea of the knowledge available on the subject and also identifies gaps where more emphasis needs to be placed. The response also provided key contacts of relevant people that could be used later in an alien species project for networking purposes. Therefore, we designed a questionnaire and emailed this to relevant government agencies, individuals linked to natural history groups and other interested individuals within the UAE (a total of 35 people/agencies). A targeted approach was used because our target frame was those individuals or agencies involved in alien species research or management. The questionnaire consisted of four sections as follows:

- Section 1: general information such as contact details, which included name, title, full name of organization/agency, mailing address, telephone, e-mail and date;
- Section 2: species details such as taxon, family, genus, species, sub-species, common name, Arabic name, whether species is record of a species occurrence (present at one point in time but did not become established) or established (maintains a breeding...
population), means of introduction (known or inferred), year first recorded, possible impacts to environment and control methods (if known);
- Section 3: species geographical information, including the native range of a species, UAE recorded distribution, particular Emirate and GPS location (if known); and
- Section 4: miscellaneous information such as literature reference(s), website addresses, references and notes.

We received a 30% response to the questionnaires, which is a good response rate for mail and email surveys (see Shough & Yates 2002; Brennan & Charbonneau 2009). As is typical with mail-out/email surveys, not all fields were completed in many instances (e.g., Trenouth et al. 2012). Particular fields that were commonly omitted included the year of introduction, on which very little information was received.

Confiscated species database and terrestrial baseline surveys

A review of EAD’s environmental databases to pinpoint further records of alien species was conducted. EAD, which conducts wildlife assessment and monitoring activities, has databases on species distribution mainly native species but occasionally alien species are also recorded. EAD is also the UAE CITES Scientific Authority agency for the UAE at the Federal level and it therefore maintains records of CITES species confiscations within the UAE. The CITES confiscations include occasional records of non-native species which have been collected in the wild such as Ball Pythons Python regius (P. Soorae, pers. obs. 2004). The CITES confiscation records provided some useful data on species collected from the wild which are mainly escapees. Therefore, these two datasets also added to the initial alien species list developed through the questionnaire and literature review. All the species identified through these various methods are illustrated in Appendix A (supplemental material).

RESULTS

A total of 146 alien species were recorded in seven major taxonomic groups as shown in Table 1. The highest number of alien species were birds recorded at 49%, followed by invertebrates at 34%, plants and reptiles and amphibians both at 5%, mammals at 4% and freshwater fish at 3% as shown in Table 1.

Invertebrates

Invasion trends & introduction pathways: The main reports of invertebrate alien species are from the 1990s (one in 1980s) with the majority having an unknown date of first introduction. Almost a third (32%) of the alien species records are listed as ‘accidental introductions’ with the remainder of 68% having an ‘unknown’ pathway/vector. There are various terrestrial alien species such as ants, spiders, weevils, slugs and snails that have been recorded within the UAE. The majority of these species, and those that have become naturalized, are mainly found in urbanized and disturbed habitats (Collingwood et al. 1997). The tropical Fire Ant Solenopsis geminata is a Central American endemic and was first recorded from Arabia in the Dubai Emirate, UAE. This species is an aggressive predator and can have a very negative impact on the ecology, by altering the local fauna through both predation and competition for food (Balfour 2003). The presence of Australian Red-back Spiders Latrodectus hasselti has also been recorded from Dubai Emirate (Balfour 2003). In the year 2010, a Red-back Spider collected in Abu Dhabi, has been confirmed as Latrodectus erythromelas by a collaborative study done by the EAD (Saji & Al Dhaheri 2010) (Image 1). These spiders are reported from domestic gardens and further research is required to understand whether these spiders are able to survive within UAE’s natural habitat.

The Red Palm Weevil Rhynchophorus ferrugineus is another alien species that is an important insect pest of date palms in the UAE and has widespread distribution in tropical Asia (Murphy & Briscoe 1999). The excessive use
of insecticides may limit the activity of natural enemies in plantations and thereby the red palm weevil has had a devastating impact in the countries of the Middle East (Murphy & Briscoe 1999). Non-native mollusk species have been recorded such as the southern Flat Coil Snail Polygyra cereolus, a native of Florida, USA, which is present in pest proportions in some lawns and garden environments. The Garden Slug Laevicaulis alte is found in regularly watered landscaped areas and cultivated sites within the UAE and these snails may compete for food with native snails. They are often imported with their nests to the UAE, in agricultural products such as soil, potted plants and compost (Feulner & Green 2003). A number of other non-native pest species have been recorded from imported foodstuffs, fruits and vegetables in the UAE (see Appendix 1).

Freshwater fish

**Invasion trends & introduction pathways:** Freshwater fish have been recorded since the year 2000 and all listed as ‘accidental introductions’. Freshwater ecosystems in the UAE are limited to seasonal rivers in mountainous areas known as ‘wadis’, and in dams that collect water during the rainy season. A majority of these are located in the northern part of the country. Different Tilapias Oreochromis spp. have been recorded in some wadis and also in dams and other freshwater bodies. In Wadi Wurayah, Fujairah Emirate, the Mozambique Tilapia Oreochromis mossambicus and mainly tropical aquarium fish such as Armored Catfish Plecostomus sp., Shark Catfish Pangasianodon hypophthalmus and Common Carp Cyprinus carpio have been recorded (Smart-Beadsmore et al. 2008; Tourenq et al. 2011). Tilapias also have also been recorded in Al Ain City in wadis and other water bodies (Soorae, pers. obs.) (Image 2). Mollies Poecilia spp. are established in irrigation ditches at Ruwayyah outside Dubai City in Dubai Emirate (Feulner 2005).

**Amphibians & Reptiles**

**Invasion trends & introduction pathways:** Like the freshwater fish, amphibians and reptiles have only been recorded since the year 2000 onwards with the majority noted between the years 2000 and 2009. A total of 72% of these alien species have been categorized as ‘escape from captivity’, with 14% as ‘accidental introductions’ and 14% as having ‘unknown’ pathways.

In general, amphibians and reptiles do not pose a major threat, as most of the records so far have been of individuals that have escaped from captivity. The Green Toad Bufo viridis, collected in Abu Dhabi City in 2006 (Soorae, pers. obs. 2006) was an obvious released pet or one that had escaped from captivity. Freshwater turtle species can pose a threat in freshwater ecosystems such as the record of a Red-eared Slider Trachemys scripta elegans from Wadi Wurayah, Fujairah Emirate (Tourenq & Shuriqi 2010). A Leopard Tortoise Stigmochelys pardalis was recorded from Bul Sayeef Island, Abu Dhabi Emirate during a routine biodiversity survey in 2008, which was most likely an abandoned pet that was left on this island (P. Soorae, pers. obs. 2008) (Image 3).

**Birds**

**Invasion trends & introduction pathways:** The majority of alien bird species records have been between the years 1980 and 2009. Two species have been recorded from 2010 to present. The main pathways are ‘accidental introductions’ (41%), followed by ‘escape from captivity’ (34%) and 25% as ‘unknown’. The most common alien bird species in the UAE is the Common Myna Acridotheres tristis and Indian House Crow Corvus splendens. The Ring-necked Parakeet Psittacula krameri (Image 4) and White-eared Bulbul Pycnonotus leucotis are also naturalized within the UAE and seen commonly in urbanized areas (Khan 1993). The Grey Francolinus Francolinus pondicerianus

| Major Taxonomic Group | Invasive Alien Species | Percentage |
|-----------------------|------------------------|------------|
| Invertebrates         | 49                     | 34%        |
| Freshwater fish       | 5                      | 3%         |
| Reptiles & Amphibians | 7                      | 5%         |
| Birds                 | 71                     | 49%        |
| Mammals               | 6                      | 4%         |
| Plants                | 8                      | 5%         |
| Total                 | 146                    | 100%       |

Table 1. The percentage of alien species in seven major taxa
mechanensis is another widespread species and there is some controversy on whether it was naturally occurring in parts of the Arabian peninsula or whether it is an introduced species as its native range is described as Afghanistan and Iran. This species has nevertheless spread widely in the UAE with greening of roadways and spread of farms, gardens and urban areas (Khan & Javed 2005). The majority of these avian species are usually found in urban and disturbed habitats. Although Indian House Crows occur in small numbers at the moment, over the years a noticeable increase in the frequency of sighting has been reported, mostly in areas close to human habitation and along the coastal strip (Ryall & Meier 2008). Several thousand house crows are present on Delma Island in the Arabian Gulf but have not fortunately spread to other nearby uninhabited islands that are used by seabirds for breeding. This could be due to the absence of human habitation and roosting trees. In the future with some islands undergoing development, the likelihood of their range extension cannot be ruled out as many offshore islands in the UAE host breeding colonies of several seabird species, many of them regionally and internationally important (Javed 2008).

Mammals

**Invasion trends & introduction pathways:** Only one out of the six mammal species has a known date of first introduction in 1999 and the other five are unknown. The main pathways are 50% accidental introductions and 50% escape from captivity. The main mammalian alien species is the feral cat *Felis domesticus*, feral dog *Canis familiaris* and rodents such as the Black Rat *Rattus rattus*, Brown Rat *Rattus norvegicus* and House Mouse *Mus musculus*. All of these alien species are common in transformed and degraded habitats. These are species that easily spread via anthropogenic activities and are also disease vectors (Shoukry 2001) and very efficient predators of native biodiversity (Javed & Khan 2005; Javed 2008; Javed et al. 2012).

With a worldwide distribution, the Brown Rat is commonly found in towns of the Arabian Peninsula (Harrison & Bates 1991). The House Mouse is found as a commensal species in towns and settlements throughout the UAE. As human settlements expand into previously unsettled areas, new habitat is ‘created’ for House Mice. Consequently, the population is thought to be expanding its geographic range and increasing in absolute numbers. This species is also found on islands of the Arabian Gulf, such as Zirku and Arzanah, Abu Dhabi Emirate where it constitutes a threat to seabird species of conservation concern (Drew et al. 2003; Javed et al. 2004). In 2014, House Mice were also recorded from Marawah Island, Abu Dhabi Emirate (P. Soorae, pers. obs. 2014). Feral cats and feral dogs have been recorded in some high biodiversity areas via camera traps and these have had a negative effect on biodiversity (P. Soorae, pers. obs. 2015). Feral cats predate on ground nesting birds feeding on eggs and chicks. The native Gordon’s Wild Cat *Felis silvestris gordoni* is threatened by genetic pollution due to interbreeding with feral domestic cats (Aspinall et al. 2005).

Plants

**Invasion trends & introduction pathways:** The records of alien plant species are from the year 2000 to present and 50% are categorized as unknown pathway, 25% each as accidental introduction and escape from cultivation. One of the main invasive alien plant species in the UAE is the Mesquite Tree *Prosopis juliflora*, which
is introduced from Central America and has spread quite extensively within the UAE. It has also colonized the many wadi environments, which have higher moisture availability, compared to the more true desert environments (El-Keblawy & Rawai 2007; Tourenq & Shuriqi 2010).

The Sea-purslane Sesuvium portulacastrum, which is native to Africa, Asia, Australia, North and South America, and the Goat Creeper Ipomoea pes-caprae that is native to South America, have become naturalized in the UAE. These are low risk species widely used for landscaping in coastal areas or where soil salinity is high (S. Sakkir, pers. obs. 2012). The common invasive grass is the Fountain Grass Pennisetum setaceum, which is a native of northern Africa, has been introduced into the UAE as an ornamental grass for its attractive inflorescence and is highly invasive with long-lived wind dispersed seeds making its control extremely difficult. It has been observed in wadis on Jebel Hafeet (S. Sakkir, pers. obs. 2014).

DISCUSSION

On an ecosystem basis (terrestrial versus freshwater) the majority of alien species were recorded from terrestrial environments (95%), and freshwater aquatic species comprised 5% of records (freshwater fish, crocodile, amphibian and aquatic turtle). The majority of alien species have been observed in urban and semi-urban habitats and those that have been disturbed by anthropogenic activities. The hyper-arid climate in the UAE ensures that alien species find it extremely difficult to get established in more wild, pristine areas as these are very challenging environments and are mainly inhabited by native species that have become highly adapted to living in these extreme conditions.

The more vulnerable are the freshwater wadi ecosystems in which the UAE’s three main native fish species and two species of regionally endemic toads are vulnerable to introduced species such as Tilapia, tropical aquarium fish, aquatic turtles and the amphibian chytridiomycosis fungus that has decimated amphibian populations worldwide (Soorae et al. 2012). This is a priority area for raising public awareness to prevent unintentional releases in these freshwater wadi systems. The main threat on native fish species would be predation, disease introduction and competition for resources. The very low numbers of fish species can be severely impacted by any freshwater alien species becoming established in these fragile ecosystems.

In conclusion this survey has highlighted the terrestrial and freshwater alien species of the UAE and this information will be useful for biodiversity conservation and management within the UAE. It would also be useful in the future to extend such a project to cover the marine environment given the high volume of international shipping in the UAE and the associated threat of alien species introduction through ballast water discharges.

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Researchers have documented a number of alien species recorded in the United Arab Emirates (UAE). This includes the Red Palm Weevil (Rhynchitellus ignotus), which was first detected in the UAE in 1999 (Murphy & Briscoe, 1999). Additionally, the House Crow (Corvus splendens) has been identified as an invasive species in the UAE (Richardson, 2003). The Red Palm Weevil and House Crow are examples of introduced species that have had significant impacts on the UAE's native ecosystems.

Other alien species recorded in the UAE include the Common Housefly (Musca domestica) and the Red Fiddler Crab (Uca pugilator). These species were first detected in the UAE in the late 1990s (Middleton & Thomas, 1997). Further studies on the invasion of alien species in the UAE have been conducted by researchers such as Pedersen and Aspinall (2010), who conducted a survey of the birds of the UAE. Their study identified a variety of alien species that have been introduced to the UAE, including birds such as the Black-capped Chickadee (Poecile atricapillus) and the Common Grackle (Quiscalus quiscula).

Despite the challenges posed by alien species in the UAE, there have been efforts to control and manage these species. For example, the removal of an introduced tilapia species from a wadi in the UAE was reported by Tourenq et al. (2011). This species, Sarotherodon galilaeus, was first detected in the UAE in the late 1990s and had a significant impact on the native fish communities in the UAE's wadis. The removal of this species was achieved through a combination of fishing and habitat manipulation.

In conclusion, the UAE has experienced significant invasions of alien species, which have had a profound impact on the country's ecosystems. Continued efforts are needed to control and manage these species to ensure the health and sustainability of the UAE's biodiversity. Further research is needed to better understand the impacts of alien species on the UAE's ecosystems and to develop effective management strategies.
Appendix 1. Table listing the terrestrial and freshwater species with their date of first record and introduction pathway

| Taxon | Family | Species | Date of first record (year) or Unknown | Introduction pathway, e.g., EC, AI, UNK | Collection Reference number | References |
|-------|--------|---------|----------------------------------------|-----------------------------------------|----------------------------|------------|
| 1     | Arachnida | Theridiidae | Red-back Spider Latrodectus erythrograms | UNK | UNK | ICEAD (Insect Collection Environment Agency Abu Dhabi) - Wet collection | Saji & Al Dhaheri 2010 |
| 2     | Arachnida | Theridiidae | Australian Red-back Spider Latrodectus hasselti | UNK | UNK | ICEAD –Wet collection | Balfour 2003 |
| 3     | Annelida | Oligochaeta: Opisthopora | Earthworm (unidentified species) | UNK | UNK | ICEAD –Wet collection | Saji 2008 |
| 4     | Mollusca | Gastropoda: Pulmonata: Polygyridae | Southern Flat Coil Polygyra cereolus | UNK | AI | ICEAD –Wet collection | Feulner & Green 2003 |
| 5     | Mollusca | Gastropoda: Pulmonata: Aroianphantidae | Flat African Slug Loewiculus alte | UNK | AI | ICEAD –Wet collection | Feulner & Green 2003 |
| 6     | Mollusca | Gastropoda: Pulmonata: Subulinae | Garlic Glass Snail Allopaeas gracilis | UNK | UNK | ICEAD –Wet collection | Feulner & Green 2003 |
| 7     | Insecta | Orthoptera: Gryllidae | House Cricket Acheta domestica | UNK | UNK | ICEAD IC3-D8 | Saji 2008 |
| 8     | Insecta | Blattodea: Blattellidae | German Cockroach Blattella germanica | UNK | UNK | ICEAD IC4-D12 | Balfour 2003 |
| 9     | Insecta | Blattodea: Blattellidae | Brown Banded Cockroach Supella langipalpa | UNK | UNK | ICEAD IC4-D12 | Balfour 2003 |
| 10    | Insecta | Blattodea: Blattellidae | American Cockroach Periplaneta americana | UNK | UNK | ICEAD IC4-D12 | Balfour 2003 |
| 11    | Insecta | Heteroptera: Pentatomidae | Southern Green Stinkbug Nezara viridula | UNK | UNK | ICEAD IC2-D14 | Saji 2008 |
| 12    | Insecta | Homoptera: Aleyrodidae | Cotton Whitefly Bemisia tabaci | UNK | UNK | ICEAD IC3-D9 | Gassouma 2003 |
| 13    | Insecta | Homoptera: Aphididae | Cotton Aphid Aphis gossypii | UNK | UNK | ICEAD IC2-D25 | Gassouma 2003 |
| 14    | Insecta | Homoptera: Aphididae | Green Peach Aphid Myzus persicae | UNK | UNK | ICEAD IC2-D25 | Gassouma 2003 |
| 15    | Insecta | Homoptera: Diaspididae | Long Scale Insect Fiorinia phoenicis | UNK | UNK | ICEAD IC2-D25 | Gassouma 2003 |
| 16    | Insecta | Homoptera: Pseudococcidae | Citrus Mealy Bug Planococcus citri | UNK | AI | ICEAD IC2-D25 | Gassouma 2003 |
| 17    | Insecta | Diptera: Muscidae | Stablefly Stomoxys calcitrans | UNK | UNK | ICEAD IC1-D6 | Balfour 2003 |
| 18    | Insecta | Diptera: Muscidae | Common Housefly Musca domestica | UNK | UNK | ICEAD IC1-D6 | Balfour 2003 |
| 19    | Insecta | Diptera: Tephritidae | Oriental Fruit Fly Bactrocera dorsalis | UNK | UNK | ICEAD IC1-D3 | Gassouma 2003 |
| 20    | Insecta | Hymenoptera: Formicidae | Ant Cardiocondyla emeryi | (1997) | UNK | ICEAD IC1-D14 | Collingwood et al. 1997 |
| 21    | Insecta | Hymenoptera: Formicidae | Singapore Ant Monomorium destructor | (1997) | UNK | ICEAD IC1-D17 | Collingwood et al. 1997 |
| 22    | Insecta | Hymenoptera: Formicidae | Argentine Ant Linepithema humile | (1997) | UNK | ICEAD IC1-D16 | Collingwood et al. 1997 |
| 23    | Insecta | Hymenoptera: Formicidae | Black Common Ant Camponotus compressus compressus | (1997) | UNK | ICEAD IC1-D14 | Collingwood et al. 1997 |
| 24    | Insecta | Hymenoptera: Formicidae | Big-headed Ant Pheidole tenerifana tenerifana | (1997) | UNK | ICEAD IC1-D17 | Collingwood et al. 1997 |
| 25    | Insecta | Hymenoptera: Formicidae | Pavement Ant Tetramorium bicarinatum | (1997) | UNK | ICEAD IC1-D17 | Collingwood et al. 1997 |
| 26    | Insecta | Hymenoptera: Formicidae | Tropical Tyrant Ant Iridomyrmex anceps | (1997) | UNK | ICEAD IC1-D16 | Collingwood et al. 1997 |
| 27    | Insecta | Hymenoptera: Formicidae | Tramp Ant Tapinoma simrothi | (1997) | UNK | ICEAD IC1-D16 | Collingwood et al. 1997 |
| Taxon | Family | Species | Date of first record (year) or Unknown | Introduction pathway, e.g., EC, AI, UNK | Collection Reference number | References |
|-------|--------|---------|--------------------------------------|------------------------------------------|-------------------------------|------------|
| 29 Insecta | Hymenoptera: Formicidae | Black-headed Ant Tapinoma melanocephalum | (1997) | UNK | ICEAD-IC1-D16 | Collingwood et al. 1997 |
| 30 Insecta | Hymenoptera: Formicidae | Ant Paratrechina falvipes | (1997) | UNK | ICEAD-IC1-D16 | Collingwood et al. 1997 |
| 31 Insecta | Hymenoptera: Formicidae | Tramp Ant Paratrechina jaegerskioeldi | (1997) | UNK | ICEAD-IC1-D16 | Collingwood et al. 1997 |
| 32 Insecta | Hymenoptera: Formicidae | Crazy Ant Paratrechina longicornis | (1997) | UNK | ICEAD-IC1-D16 | Collingwood et al. 1997 |
| 33 Insecta | Hymenoptera: Formicidae | Samsam Ant Pachycondyla sennoarenensis | (1997) | UNK | ICEAD-IC1-D5 | Collingwood et al. 1997 |
| 34 Insecta | Hymenoptera: Formicidae | Tropical Fire Ant Solenopsis geminata | (1997) | UNK | n/a | Collingwood et al. 1997 |
| 35 Insecta | Lepidoptera: Noctuidae | Cabbage Looper Trichoplusia ni | | AI | ICEAD-IC2-D8 | Gassouma 2003 |
| 36 Insecta | Lepidoptera: Noctuidae | Corn Earworm Helicoverpa armigera | | AI | n/a | Collingwood et al. 1997 |
| 37 Insecta | Lepidoptera: Nolidae | Egyptian Bollworm Earias insulana | | AI | ICEAD-IC1-D6 | Collingwood et al. 1997 |
| 38 Insecta | Lepidoptera: Pyralidae | Indian Meal Moth Plodia interpunctella | | AI | ICEAD-IC2-D2 | Saji 2008 |
| 39 Insecta | Lepidoptera: Pyralidae | Warehouse Moth Cadra cautella | | AI | ICEAD-IC2-D2 | Saji 2008 |
| 40 Insecta | Lepidoptera: Plutellidae | Diamondback Moth Plutella xylostella | | AI | ICEAD-IC2-D2 | Saji 2008 |
| 41 Insecta | Lepidoptera: Pieridae | Diamondback Moth Plutella xylostella | | AI | ICEAD-IC2-D2 | Saji 2008 |
| 42 Insecta | Coleoptera: Anobiidae | Cigarette Beetles Lasioderma serricorne | | AI | ICEAD-IC2-D2 | Saji 2008 |
| 43 Insecta | Coleoptera: Anobiidae | Drugstore Beetle Stegobium panicum | | AI | ICEAD-IC2-D2 | Saji 2008 |
| 44 Insecta | Coleoptera: Curculionidae | Red Palm Weevil Rhynchophorus ferrugineus | (1986) | UNK | ICEAD-IC5-D8 | Gassouma 2003 |
| 45 Insecta | Coleoptera: Curculionidae | Sweet Potato Weevil Cylas formicarius | | AI | ICEAD-IC5-D8 | Saji and Mayas 2006 |
| 46 Insecta | Coleoptera: Curculionidae | Rice Weevil Sitophilus granarius | | AI | ICEAD-IC5-D8 | Saji and Mayas 2006 |
| 47 Insecta | Coleoptera: Curculionidae | Merchant Grain Beetle Oryzaephilus mercator | | AI | ICEAD-IC5-D8 | Saji and Mayas 2006 |
| 48 Insecta | Coleoptera: Dermentidae | Khapra Beetle Trogoderma granarium | | AI | ICEAD-IC4-D5 | Saji and Mayas 2006 |
| 49 Insecta | Coleoptera: Dynastidae | Date Palm Beetle Oryctes rhinoceros | | AI | ICEAD-IC4-D6 | Gassouma 1991 |
| 50 Pisces | Cichlidae | Tilapia Oreochromis mossambicus and other unidentified species | | AI | n/a | Tourouq et al. 2011; Smart-Beadsmore et al. 2008; Soorae, personal observation |
| 51 Pisces | Pangasiidae | Shark Catfish Pangasianodon hypophthalmus | | AI | n/a | Tourouq et al. 2011; Smart-Beadsmore et al. 2008 |
| 52 Pisces | Cyprinidae | Carp Cyprinus carpio | | AI | n/a | Tourouq et al. 2011; Smart-Beadsmore et al. 2008 |
| 53 Pisces | Loricariidae | Armored Catfish Pecosomus sp. | | AI | n/a | Tourouq and Mayas 2006 |
| 54 Pisces | Poeciliidae | Mollies Poecilia sp. | | AI | n/a | Feulner 2005 |
| 55 Amphibia | Bufonidae | Green Toad Bufo viridis | 2006 | EC | n/a | Soorae, personal observation |
| 56 Reptilia | Crocodylidae | Nile Crocodile Crocodylus niloticus | | UNK | n/a | Gardner 2005 |
| 57 Reptilia | Emydidae | Red-eared Slider Trachemys scripta elegans | 2010 | AI | n/a | Tourouq 2010 |
| Taxon   | Family            | Species                          | Date of first record (year) or Unknown | Introduction pathway, e.g., EC, AI, UNK | Collection Reference number | References                                      |
|---------|-------------------|----------------------------------|---------------------------------------|-----------------------------------------|------------------------------|------------------------------------------------|
| 58      | Reptilia          | Testudinidae                     | 2008                                  | EC                                      | n/a                          | Soorae, personal observation                    |
| 59      | Reptilia          | Gerrhosauridae                   | 2007                                  | EC                                      | n/a                          | Soorae, personal observation                    |
| 60      | Reptilia          | Iguanidae                        | 2007                                  | EC                                      | n/a                          | http://gulfnews.com/ news/gulf/uae/general/ runaway-iguana-triggers-panic-among-residents-1.205299 |
| 61      | Reptilia          | Pythonidae                       | 2006                                  | EC                                      | n/a                          | Soorae, personal observation                    |
| 62      | Birds             | Struthionidae                    | 2002                                  | Al                                      | n/a                          | Javed and Khan, personal observation 2012        |
| 63      | Birds             | Numididae                        | 2010                                  | AI, EC                                  | n/a                          | Pedersen & Aspinall 2010                        |
| 64      | Birds             | Phasianidae                      | 1989                                  | AI, EC                                  | n/a                          | Pedersen & Aspinall 2010                        |
| 65      | Birds             | Phasianidae                      | 1989                                  | AI, EC                                  | n/a                          | Pedersen & Aspinall 2010                        |
| 66      | Birds             | Phasianidae                      | 1989                                  | AI, EC                                  | n/a                          | Pedersen & Aspinall 2010                        |
| 67      | Birds             | Phasianidae                      | 1980's                                | AI                                      | n/a                          | Pedersen & Aspinall 2010                        |
| 68      | Birds             | Phasianidae                      | 1980's                                | AI                                      | n/a                          | Pedersen & Aspinall 2010                        |
| 69      | Birds             | Phasianidae                      | 1980's                                | AI                                      | n/a                          | Pedersen & Aspinall 2010                        |
| 70      | Birds             | Phasianidae                      | 1980's                                | AI, EC                                  | n/a                          | Pedersen & Aspinall 2010                        |
| 71      | Birds             | Phasianidae                      | 1980's                                | AI, EC                                  | n/a                          | Pedersen & Aspinall 2010                        |
| 72      | Birds             | Phasianidae                      | 1980's                                | AI, EC                                  | n/a                          | Pedersen & Aspinall 2010                        |
| 73      | Birds             | Anatidae                         | 1981                                  | AI, EC                                  | n/a                          | Pedersen & Aspinall 2010                        |
| 74      | Birds             | Anatidae                         | 1989                                  | AI, EC                                  | n/a                          | Pedersen & Aspinall 2010                        |
| 75      | Birds             | Anatidae                         | 1989                                  | AI, EC                                  | n/a                          | Pedersen & Aspinall 2010                        |
| 76      | Birds             | Anatidae                         | 1989                                  | AI                                      | n/a                          | Pedersen & Aspinall 2010                        |
| 77      | Birds             | Anatidae                         | 1980's                                | EC                                      | n/a                          | Richardson 1997; Javed 2008; Khan 1993           |
| 78      | Birds             | Ciconiidae                       | 1980's -                              | EC                                      | n/a                          | Pedersen & Aspinall 2010                        |
| 79      | Birds             | Ciconiidae                       | 1999                                  | EC                                      | n/a                          | Richardson 2003; Pedersen & Aspinall 2010       |
| 80      | Birds             | Threskiornithidae                 | 1980's                                | EC                                      | n/a                          | Richardson 2003; Pedersen & Aspinall 2010       |
| 81      | Birds             | Threskiornithidae                 | 1993                                  | AI, EC                                  | n/a                          | Pedersen & Aspinall 2010                        |
| 82      | Birds             | Accipitridae                      | 1988                                  | AI                                      | n/a                          | Pedersen & Aspinall 2010                        |
| 83      | Birds             | Ardeidae                         | 1989                                  | EC                                      | n/a                          | Richardson 1997; Javed 2008                     |
| 84      | Birds             | Ardeidae                         | 1993                                  | EC                                      | n/a                          | Pedersen & Aspinall 2010                        |
| 85      | Birds             | Otididae                         | 1996                                  | AI                                      | n/a                          | Pedersen & Aspinall 2010                        |
| 86      | Birds             | Ratitidae                        | 1997                                  | AI                                      | n/a                          | Pedersen & Aspinall 2010                        |
| 87      | Birds             | Gruidae                          | 1997                                  | EC                                      | n/a                          | Richardson 1997                                |
| 88      | Birds             | Gruidae                          | 1994                                  | EC                                      | n/a                          | Richardson 2003; Pedersen & Aspinall 2010       |
| 89      | Birds             | Columbidae                       | 1993                                  | AI                                      | n/a                          | Pedersen & Aspinall 2010                        |
| Taxon | Family | Species | Date of first record (year) or Unknown | Introduction pathway, e.g., EC, AI, UNK | Collection Reference number | References |
|-------|--------|---------|---------------------------------------|----------------------------------------|-----------------------------|--------------------------|
| 90    | Birds  | Columbidae | Ringed Turtle Dove Streptopelia roseogrisea | 1990's | AI | n/a | Pedersen & Aspinall 2010 |
| 91    | Birds  | Columbidae | Speckled Pigeon Columba guinea | 2005 | AI | n/a | Pedersen & Aspinall 2010 |
| 92    | Birds  | Pteroclidae | Pin-tailed Sandgrouse Pterocles alchata | 1997 | AI | n/a | Richardson 2003; Pedersen & Aspinall 2010 |
| 93    | Birds  | Psittacidae | Alexandrine Parakeet Psittacula eupatria | 1997 | AI | n/a | Richardson 1997; Javed 2008 |
| 94    | Birds  | Psittacidae | Blossom-headed Parakeet Psittacula roseata | 1997 | AI | n/a | Richardson 1997; Pedersen & Aspinall 2010 |
| 95    | Birds  | Psittacidae | Budgerigar Melopsittacus undulatus | UNK | AI, EC | n/a | Pedersen & Aspinall 2010 |
| 96    | Birds  | Psittacidae | Monk Parakeet Myiopisitta monachus | 2005 | AI | n/a | Pedersen & Aspinall 2010 |
| 97    | Birds  | Psittacidae | Nanday Parakeet Nandayus nenday | 2007 | EC | n/a | Pedersen & Aspinall 2010 |
| 98    | Birds  | Psittacidae | Plum-headed Parakeet Psittacula cyanoptera | 1996 | AI, EC | n/a | Pedersen & Aspinall 2010 |
| 99    | Birds  | Psittacidae | Rose-ringed Parakeet Psittacula krameri | UNK | UNK | n/a | Pedersen & Aspinall 2010 |
| 100   | Birds  | Corvidae | House Crow Corvus splendens | UNK | UNK | n/a | Richardson 1997; Javed 2008; Khan 1993 |
| 101   | Birds  | Corvidae | Large-billed Crow Corvus macrorhynchos | 1998 | EC | n/a | Pedersen & Aspinall 2010 |
| 102   | Birds  | Pycnonotidae | Red-vented Bulbul Pycnonotus cafer | 1997 | UNK | n/a | Richardson 1997; Javed 2008; Khan 1993 |
| 103   | Birds  | Pycnonotidae | Red-whiskered Bulbul Pycnonotus jocosus | 1997 | UNK | n/a | Richardson 1997; Javed 2008 |
| 104   | Birds  | Pycnonotidae | White-eared Bulbul Pycnonotus leucotis | UNK | UNK | n/a | Javed 2008; Khan 1993 |
| 105   | Birds  | Sturnidae | Bank Mynah Acridotheres ginnianus | UNK | UNK | n/a | Javed 2008 |
| 106   | Birds  | Sturnidae | Brahminy Starling Ternænæus paparator | 1997 | UNK | n/a | Richardson 1997; Javed 2008 |
| 107   | Birds  | Sturnidae | Common Mynah Acridotheres tristis | UNK | UNK | n/a | Javed 2008; Khan 1993 |
| 108   | Birds  | Sturnidae | Common Starling Sturnus vulgaris | 1997 | UNK | n/a | Javed 2008 |
| 109   | Birds  | Sturnidae | Javan Mynah Acridotheres javanicus | 1990's | EC | n/a | Pedersen & Aspinall 2010 |
| 110   | Birds  | Sturnidae | Jungle Mynah Acridotheres fuscus | 1980's | AI | n/a | Pedersen & Aspinall 2010 |
| 111   | Birds  | Sturnidae | Pied Myna Grecupica contra | 1997 | UNK | n/a | Richardson 1997; Javed 2008 |
| 112   | Birds  | Sturnidae | Rose-colored Starling Pastor roseus | 1997 | UNK | n/a | Richardson 1997; Javed 2008 |
| 113   | Birds  | Sturnidae | Superb Starling Lamprotornis superbus | 2010 | AI, EC | n/a | Pedersen & Aspinall 2010 |
| 114   | Birds  | Ploceidae | Baya Weaver Ploceus philippinus | 1995 | AI, EC | n/a | Pedersen & Aspinall 2010 |
| 115   | Birds  | Ploceidae | Bengal Weaver Ploceus bengaliae | 2006 | AI, EC | n/a | Pedersen & Aspinall 2010 |
| 116   | Birds  | Ploceidae | Chestnut Weaver Ploceus rubiginosus | 1995 | EC | n/a | Richardson 2003; Pedersen & Aspinall 2010 |
| 117   | Birds  | Ploceidae | Lesser Masked Weaver Ploceus intermedius | UNK | UNK | n/a | Pedersen & Aspinall 2010 |
| 118   | Birds  | Ploceidae | Rueppell's Weaver Ploceus galbula | UNK | UNK | n/a | Pedersen & Aspinall 2010 |
| 119   | Birds  | Ploceidae | Streaked Weaver Ploceus manyar | 1995 | AI, EC | n/a | Richardson 1997; Richardson 2003 |
| 120   | Birds  | Ploceidae | Village Weaver Ploceus cucullatus | UNK | UNK | n/a | Pedersen & Aspinall 2010 |
| 121   | Birds  | Ploceidae | Vitelline Masked Weaver Ploceus vitellinus | UNK | UNK | n/a | Pedersen & Aspinall 2010 |
| 122   | Birds  | Ploceidae | Golden-backed Weaver Ploceus jacksoni | 2003 | AI | n/a | Richardson 2003 |
| Taxon | Family | Species | Date of first record (year) or Unknown | Introduction pathway, e.g., EC, AI, UNK | Collection Reference number | References |
|-------|--------|---------|----------------------------------------|----------------------------------------|----------------------------|------------|
| 123 Birds | Ploceidae | Black-winged Bishop *Euplectes hordeaceus* | UNK | AI, EC | n/a | Pedersen & Aspinall 2010 |
| 124 Birds | Ploceidae | Red-billed Quelea *Quelea quelea* | 1995 | AI, EC | n/a | Richardson 1997; Pedersen & Aspinall 2010 |
| 125 Birds | Ploceidae | Southern Red Bishop *Euplectes orix* | UNK | AI, EC | n/a | Pedersen & Aspinall 2010 |
| 126 Birds | Ploceidae | Yellow-crowned Bishop *Euplectes afer* | 2005 | AI | n/a | Pedersen & Aspinall 2010 |
| 127 Birds | Estrildidae | Chestnut Munia *Lonchura atricapilla* | UNK | UNK | n/a | Pedersen & Aspinall 2010 |
| 128 Birds | Estrildidae | Common Waxbill * Estrilda astrild* | 2007 | AI, EC | n/a | Pedersen & Aspinall 2010 |
| 129 Birds | Estrildidae | Indian Silverbill *Lonchura malabarica* | 1997 | UNK | n/a | Richardson 1997; Khan 1993 |
| 130 Birds | Estrildidae | Java Sparrow * Padda oryzivora* | UNK | UNK | n/a | Richardson 1997; Pedersen & Aspinall 2010 |
| 131 Birds | Estrildidae | Red Avadavat * Amandava amandava* | 1988 | AI, EC | n/a | Richardson 1997; Pedersen & Aspinall 2010 |
| 132 Birds | Viduidae | Pin-tailed Whydah *Vidua macroula* | 1997 | AI, EC | n/a | Richardson 1997; Pedersen & Aspinall 2010 |
| 133 Mammalia | Felidae | Feral Cat *Felis domesticus* | UNK | EC | n/a | Soorae, personal observation (2011) |
| 134 Mammalia | Rodentia | Black Rat *Rattus rattus* | UNK | AI | n/a | Aspinall, Hellyer & Drew 2005 |
| 135 Mammalia | Rodentia | Brown Rat *Rattus norvegicus* | UNK | AI | n/a | Aspinall, Hellyer & Drew 2005 |
| 136 Mammalia | Canidae | Feral Dog *Canis domesticus* | UNK | EC | n/a | Soorae, personal observation |
| 137 Mammalia | Rodentia | House Mouse *Mus musculus* | UNK | AI | n/a | Drew et al. 2003 |
| 138 Mammalia | Procaviidae | Rock Hyrax *Procavia capensis* | 1999 | EC | n/a | Cunningham 1999 |
| 139 Plants | Mimosaceae | Mesquite *Prosopis juliflora* (Sw.) DC. | UNK | UNK | TERC (Terrestrial Environment Research center) 01460 | Yourenq et al. 2010; Brown 2008; El-Keblawy et al. 2007 |
| 140 Plants | Mimosaceae | Coffee *Senna Cassia occidentalis* (L.) | 2010 | UNK | TERC00981 | Sakkir & Kabshawi, personal observation 2010 |
| 141 Plants | Convolvulaceae | Goat Creeper *Ipomoea pes-caprae* (L.) | 2010 | AI | n/a | Sakkir & Kabshawi, personal observation 2010 |
| 142 Plants | Orchidaceae | Soldier’s Orchid *Zeuxine strateumatica* | 2006 | AI | n/a | http://www.enhg.org/trb/v16n1/ TribulusV16N 1P19.pdf |
| 143 Plants | Aizoaceae | Sea Purslane *Sesuvium portulacastrum* | 2011 | UNK | n/a | Sakkir, personal observation 2011 |
| 144 Plants | Poaceae | Fountain Grass *Penisetum setaceum* | UNK | UNK | TERC00320 | http://www.nps.gov/plants/alien |
| 145 Plants | Cactaceae | Prickly Pear *Opuntia ficus-indica* | 2014 | EC* | WAM3215 | Sakkir, personal observation 2014 |
| 146 Plants | Fabaceae | Manila Tamarind *Pitheccllobium dulce* | 2015 | EC* | WAM3210 | Sakkir, personal observation 2015 |

EC - Escape from Captivity; AI - Accidental Introduction; UNK - Unknown