

Current State of Knowledge on Invasive and Alien Fauna of Nepal

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ABSTRACT

This study produced a comprehensive list of introduced fauna of Nepal. Of the sixty four species of alien fauna reported, there were seven species of mammals with forty improved breeds of cow, buffalo, goat, sheep and pig, six species of birds with eight breeds of chicken and duck, nineteen species of fish, twenty two species of arthropods including one species of freshwater prawn and twenty one species of insects, nine species of molluscs and one species of platyhelminths. Among reported alien species *Achatina fulica*, *Capra hircus*, *Clarius batrachus*, *Cyprinus carpio*, *Gambusia affinis*, *Oncorhynchus mykiss*, *Oreochromis mossambicus*, *Oryctolagus cuniculus*, *Platydemus manokwari*, and *Sus scrofa* are considered the worst species of the world and listed in '100 of the World's Worst Invasive Alien Species'. The impacts of all these serious animals in Nepal are still to be studied but some problematic species of agricultural pests, freshwater habitat as well as livestock breeds are discussed in this paper.

Keywords: Invasive species, pests, snail, slug, livestock breeds, leaf minor.

INTRODUCTION

Several terminologies have been used for alien species such as exotic species, introduced species, non-native species, non-indigenous species and invasive species. The Convention on Biological Diversity (CBD) defines alien species as "species, subspecies or lower taxon, introduced outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce" (<https://www.cbd.int/invasive/terms.shtml>). Similarly, IUCN defines alien invasive species as "an alien species which becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity" (<http://www.iucn.org>).

Not all alien species are invasive; alien species that establish in natural and semi-natural systems and cause negative impacts on those ecosystems, native species and their habitat are classified as Invasive Alien Species (IAS). The impacts of IAS are widely recognized as one of the major factors for biodiversity loss; mechanisms of impact include competition with, and predation on native species, hybridization with native species, changes in ecosystem processes, habitat modification and an increase of pests and diseases (Vitousek *et al.* 1996, Ruiz *et al.* 1997, Mack *et al.* 2000, Crooks 2002, Bruno *et al.* 2005, Rodriguez 2006), often resulting in a significant loss of native species, decline in ecosystem services and subsequent socio-economic impacts (Pimental *et al.* 2001, Hulme 2003).

IAS are represented in all major taxonomic groups, such as micro-organisms, fungi, plants, invertebrates,

fish, amphibians, reptiles, birds and mammals (Lowe *et al.* 2000). IAS are introduced by human agencies either accidentally (with trading goods) or intentionally and also in the form of commodities such as livestock, pets, nursery stock, and produce from agriculture and forestry or contaminants (McNeely *et al.* 2001).

In Nepal, alien fauna have been poorly investigated and relatively neglected in comparison to alien plant species. Budha (2013) produced the first preliminary documentation on alien and invasive alien fauna of Nepal and provided information on twenty seven alien animal species, however, many more species need to be included to produce a more comprehensive list of alien animal species of Nepal and their impact studies are still lacking. This is the first attempt to update baseline information on alien and invasive fauna of Nepal (excluding zoo animals) which also addresses Aichi Target 9 that aims "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." The list of alien/invasive mammals, birds, fish, insects, molluscs and helminthes of Nepal and their impacts will be useful for policy makers, conservationists, educationalists, researchers and students.

MATERIALS AND METHODS

This work was primarily based on field observations, as well as the best available published information. A comprehensive literature review was undertaken to collect data on known alien and IAS in Nepal. Native ranges of

species were verified and the year of introduction/first report in Nepal, for each species was documented where data was available. The list of known alien and IAS animal species and their impacts on biodiversity, food security and human health are also discussed.

RESULTS

This study reported sixty four species of alien fauna of Nepal for the first time. These have been grouped into mammals (livestock/feral), birds (including poultry birds, such as chicken, ducks, turkeys, large flightless birds and common pet parakeets), fish, freshwater prawns, insects (primarily agricultural pests and biocontrol agents viz. parasitoids, predators) and one species of flatworm. All introduced animal species are discussed separately in groups, and the complete list is given in Annex 1.

Introduced Mammals

Most of the introduced mammals are livestock breeds. Altogether seven species of livestock are reported including Alpaca and Angora rabbits. Among the ungulates that have been introduced, there are breeds of *Bos taurus* (cows- 8 breeds), *Bubalus bubalis* (buffalos- 2 breeds), *Capra hircus* (goats- 10 breeds), *Ovis aries* (sheep-10 breeds), *Sus scrofa* (pigs-7 breeds plus a feral wild boar), and *Vicugna pacos* (Alpaca- 1). One species *Oryctolagus cuniculus* (Angora rabbit-1) was also introduced (see Annex 1).

Introduced Birds

Six species of exotic bird species including the common pet parakeet, budgerigar have been introduced in Nepal, most of the species for farming purposes, they are: *Gallus gallus* (chicken- 6 breeds: New Hampshire, White Leghorn, Australorp, Giriraja, Broiler, Layer), *Anas platyrhynchos* (duck- 2 breeds: Peking duck, Ng Chow duck), *Melliagris gallapavo* (turkey), *Struthio camelus* (ostrich), and *Dromaius novaehollandiae* (emu) (see Annex 1).

Introduced Fish

Altogether nineteen introduced fish species have been reported in Nepal. They are: two catfish species (*Clarias batrachus* and *C. gariepinus*), seven carp species (*Ctenopharyngodon idella*, *Cyprinus carpio*, *Hypophthalmus molitrix*, *H. nobilis*, *Carassius auratus*, *C. carassius*), two barbs (*Barbonymus gonionotus*, *Cyclocheilichthys apogon*), one mosquito fish (*Gambusia affinis*), one iridescent shark (*Pangasius hypophthalmus*), two species of tilapia (*Oreochromis mossambicus*, *O. niloticus*), one species of cichlid (*Xenotilapia longispinis*) and three species of salmon (*Oncorhynchus mykiss*, *O. rhodurus*, *Salmo trutta*) (see Annex 1).

Introduced Insects and Freshwater Prawns

Twenty species of arthropods, including *Macrobrachium rosenbergii* (giant freshwater prawn) and twenty one species of insects are listed. Among the insects there are eight species of Diptera belonging to two families Agromyzidae and Tephritidae), five species of Homoptera belonging to four families Aphididae (2 species), one species of each family Diaspididae, Margarodidae, Psyllidae; one species of Coleoptera belonging to Chrysomelidae, four species of Hymenoptera belonging to the family Barconidae (2 species), Encyrtidae (1 species) and Apidae (1 species) and two species of Lepidoptera belonging to one species of each family Bombycidae and Gelechiidae (see Annex 1).

Introduced Molluscs

Among the introduced molluscs are two species of slugs (*Deroceras laeve* and *Laevicaulis alte*) and six species of snails *Achatina fulica* (= *Lissachatina fulica*), *Filopaludina sumatrensis*, *Pseudosuccinea columella*, *Planorbis corneus* and *Gullela bicolor*. *Pomacea canaliculata* is potential invader not yet confirmed.

Introduced Flatworm

Only one species of flatworm *Platydemus manokwari* has been reported in Nepal, which is a predator of snails and slugs and considered as one of the worst invasive species worldwide.

DISCUSSION

The status of many introduced alien species has still been overlooked in Nepal. The increasing trend of introducing animals for commercial purposes without an impact analysis has had negative impacts on the local environment and native species.

The raising of livestock is a fundamental component of the Nepalese rural farming system that provides resources for cultivating farmland, as well wool, meat and milk. It has been the second major economic activity which has substantially contributed to household incomes. Out of around 35 percent national GDP contributed by agriculture sector (MOAD 2011/12) livestock products shares 13 percent (Thakuri 2012). Livestock development was initiated in the beginning of the 1950s in Nepal (Shrestha & Pradhan 1995), however the first introduction of Jersey cows dates back to Jung Bahadur Rana regime, who imported the Jersey cows from the UK in the 1850s (www.nlbc.gov.np). Livestock development always remains the government's priority to increase national production. The importing of new animals and bird species has increased over the last few decades viz. introduction of alpaca, ostrich and emu for commercial farming purposes. With increasing

livestock business, problem of livestock diseases has also increased significantly. Thousands of outbreaks of Foot and Mouth Disease (FMD), Pests des Petits in Ruminants (PPR), Classical Swine Fever (CSF), have been observed throughout the country (Thakuri 2012).

Feral animals have also created human-wildlife conflict in several places in Nepal. Feral pig *Sus scrofa*, which was nominated as among 100 of the 'World's Worst' invaders (www.issg.org) was introduced to Nepal in the 1970s by King Mahendra Bir Bikram Shah as a gift from Russia (Chalise 2013). Although, there are no official records available of the exact date of import of this species, it could have been reared in the Royal palace before the King's death in 1972 and later released into the natural forest of the Shivapuri area in the 1980s (HMG/N 1995). According to Chalise (2013) the introduced species has spread in hills from east to west, however, it is a matter of investigation as to whether the introduced wild boar is restricted within Shivapuri area or has spread to other parts of the country.

Fisheries and aquaculture is another priority sector to the government of Nepal to boost fish production. The fisheries sector contributed about one percent in national GDP and three percent in AGDP with a growth rate of over six percent (Mishra & Upadhyaya 2011). Many introduced species *viz.* salmon, carp, cichlid, tilapia, catfish and aquarium fish have been commercially exploited in different parts of the country in ponds, natural lakes, reservoirs and cold water river streams. The exact number of exotic fish species in Nepal varies according to different authors ranging from eight to eleven species (Shrestha 1994, 2013, Sharma 2008), however, the list of most of the aquarium species has not yet been updated. This paper identified nineteen species of introduced fish species.

Among the insects, the two most commercial species *Bombyx mori* and *Apis mellifera* are well established in Nepal. Based on the definition and impact on native bee *A. cerana*, the European honey bee *A. mellifera* is considered as an invasive species.

Impacts of Invasive Species

There are many examples of impacts due to IAS across the world, such as evolutionary impacts by altering the evolutionary pathway of native species by competitive exclusion (Mooney & Cleland 2001), niche displacement (Race 1982, Kenward & Holm 1993), hybridization, introgression (Rhymer & Simberloff 1996), predation, and ultimately extinction (Clavero & Garcia-Berthou 2005). But the impact analysis of introduced fauna of many species in Nepal has not yet been fully investigated.

Most of the species intentionally introduced for

commercial purposes are livestock and fishery. But impact due to these species has already been noticed in Nepal. The local breed of cow in the far west Nepal, Achhame, is considered as an endangered endemic breed due to its rapidly decreasing population (Mahato & Gorkhali 2011). The lulu cow, which is a local breed from eastern Nepal has been replaced by the Siri breeds (Shah 2010). The introgression of exotic genes into livestock breeds through crossbreeding programmes may lose the genetic polymorphism/diversity of the breeds which may ultimately lead to the extinction of the breeds (Mahato & Gorkhali 2011). Outbreaks of diseases is another serious problem due to such introductions (Thakuri 2012).

The impacts of feral pigs *S. scrofa* across the globe are discussed in the Global Invasive Species Database (<http://www.issg.org>). In Nepal, the introduced *S. scrofa* is the most problematic wild animal in Nagarjun-Shivapuri National Park, causing human-wildlife conflict. The author observed evidence that the pigs were consuming snails *viz.* *Bensonies* spp., *Oxytesta* spp. and *Cyclophorus* spp. in the Park and found reduced populations of these snails in the area.

It was reported that there has been a forty two percent reduction of native fish in Begnash lake, Pokhara after the introduction of bighead carp, silver carp and grass carp (Swar & Gurung 1988) and increasing and decreasing trends of production of introduced fish and native fish respectively in Phewa lake (Husen 2014). More than seven species have vanished from Indrasarobar (Swar 1992) and only two native fish species *Neolissocheilus hexagonolepis* and *Nazirator chelynoides* remain (Saud & Shrestha 2007). The invasive tilapia fish in Yamuna river eat detritus, filamentous and cellular algae, zooplankton, fish and insects. It has spread to Godavari, Krishna, Cauveri, Yamuna and Ganga river in India (Ganie *et al.* 2013). Rainbow trout, one of 100 of the World's Worst Invasive Species' (Lowe *et al.* 2000) has been introduced to 87 countries worldwide (Welcomme 1992) as commercial table and game fish. Rainbow and brown trout have negative impacts on local biodiversity in established areas (Kitano 2004). These two species have been successfully established in rivers and streams in Japan and India (Himachal Pradesh, NW India) (<http://hpfisheries.gov.in>). They have caused native fish species to change their foraging habitats by reducing prey species by seventy five percent (Fausch *et al.* 1997, Nakano *et al.* 1999). In Nepal, they are highly prioritized species for commercial purposes (Gurung 2008) but they are voracious predators and feed on natural aquatic fauna if released into natural water bodies. Budha (2013) noted comparatively rapid growth of unintentionally released rainbow trout in the natural cold streams than in the fish

farm in Rasuwa, Nepal. *C. batrachus*, an air breathing catfish, native to SE Asia (Indonesia), is also one of the 'world's worst invasive species' and has been introduced to several parts of the world, including Nepal. Another catfish is *C. garipenius*, which is native to Africa is also commercially farmed in Nepal. It has been reported in the natural river system in eastern Nepal, tributaries of Tamor river (Sharma 1999).

The insect pest species cause major problems in agricultural productivity by reducing significant loss of yield, for example the PTM causes thirty to eighty five percent losses of stored potato and the standing crop (Joshi 1989, Lal 1998, Chandla & Verma 1998, Chandel & Chandla 2005), often reached complete loss during heavy infestation if control measures are not applied (NPRP 2004/05, SSMP 2008). *L. huidobrensis* is a serious pest for the floriculture and vegetable crop industries, where leaf-miner damage directly affects the marketable portion. Many other species emerged as serious problems in agriculture viz. the San José Scale *Q. perniciosus*, the *Leucaena* Psyllid and *H. cubana*. Introduction of *A. mellifera* in Asia has encountered a number of problems, such as the inter-species transmission of bee pests and diseases (Ahmad *et al.* 2004), robbing and displacing the native bee *A. cerana* (Verma 1992).

The giant African snail is another species included in '100 of the world's worst invasive alien species' list. A single pair of snails were released in Calcutta by a British malacologist, William Henry Benson in 1847 (Naggs 1997) and spread to the entire continent. It was likely introduced to Nepal during the 1930s-1940s in eastern Nepal (Budha & Naggs 2008, Raut 1999) and is now established in all Tarai districts of Nepal, including several hill districts, such as Kaski, Parbat, Baglung, Gulmi, Syangjha, Palpa, Surkhet, Chitwan, Dhading, Myagdi and Dang. It is a serious pest of crops, vegetables and fruits in most of the established areas. The rate of spread has been very rapid and it has been considered that one of the main causes of its dispersal in Nepal is due to its attractive shell (Budha & Naggs 2008).

The terrestrial flatworm *P. manokwari* is another invasive species; feeding upon native snails and earthworms in its introduced range. Terrestrial molluscs are the principal prey in the field (Justine *et al.* 2014). Author has recently been reported it from Langtang National Park and Nagarjun-Shivapuri National Park (unpublished data). It is still not known how it has been introduced into these areas.

CONCLUSION

Altogether sixty four alien species have been reported in this paper, including twenty one species of insects,

which includes commercial insects, pests and biocontrol agents (predator, parasitoid, defoliator, gall insect), one freshwater prawn, one species of flatworm, nineteen species of fish, six species of birds, and seven species of mammals including one feral pig. Out of all reported alien species ten are among the world's worst IAS. Impact studies of most of the invasive species is severely lacking, however, negative impacts on crop yields and native fauna have been documented for some species.

ACKNOWLEDGEMENTS

This paper was presented in the International Conference on Invasive Alien Species Management, organized by National Trust for Nature Conservation March 25-27, 2014, Chitwan. I would like to thank Shyama Pagad, Program Officer, IUCN SSC Invasive Species Specialist Group, for checking the initial manuscript and providing input to improve the paper and Carola Warner, University of Auckland, New Zealand for proof reading the manuscript.

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Annex1. Introduced Fauna of Nepal including Livestock and feral breeds

Scientific Name	Common name	Year of Introduction	Country of origin	Reference
MAMMALS				
Order: Artiodactyla				
Family: Bovidae				
Subfamily: Bovinae				
Cows				
<i>Bos taurus</i> Linnaeus, 1758	Jersey ¹	1850	UK	www.nlbc.gov.np
	Holeistin ¹	1950s	EU	Shrestha & Pradhan 1995
	Brown Swiss ¹	1957	USA	Shrestha & Pradhan 1995
	Haryana ¹	1964	India	Shah 2010
	Sindhi ¹	1952	India	Shah 2010
	Tharparkar ¹	1950s	India	Shah 2010
	Siri ¹	1950s	India	Shah 2010
	Ayrshire ¹	1960s	Unknown	Shrestha & Pradhan 1995
Buffalo				
<i>Bubalus bubalis</i> Linnaeus, 1758	Murrha ¹	1967	India	Shrestha & Pradhan 1995
	Nili Ravi ¹			Rasali 2000
Subfamily: Caprinae				
Goats				
<i>Capra hircus</i> Linnaeus, 1758	Jamunapari ¹	1976	India	Paudel <i>et al.</i> 2013
	Barbari ¹	1975	India	Paudel <i>et al.</i> 2013
	Ajmeri (Sirohi) ¹		India	Paudel <i>et al.</i> 2013
	Boer ¹	2013	S Africa	Paudel <i>et al.</i> 2013
	Bittal (Beetal) ¹		India	Paudel <i>et al.</i> 2013
	Sannen (Saanen) ¹	1966	Israel	Shrestha & Pradhan 1995, Paudel <i>et al.</i> 2013
	Bengal black ¹		India	
	Toggenburg ¹		Europe	Paudel <i>et al.</i> 2013
	Alpine ¹		Europe	Paudel <i>et al.</i> 2013
Kiko ¹	1980s	New Zealand	Shrestha & Pradhan 1995	
Sheep				
<i>Ovis aries</i> Linnaeus, 1758	Corriedale ¹	1958/59	UK	Shrestha & Pradhan 1995
	Merinod'arle ¹	1970s	New Zealand	Shrestha & Pradhan 1995
	Australian merino ¹	1970s	Australia	Shrestha & Pradhan 1995
	Polwarth ¹	1970	Australia	Shrestha & Pradhan 1995
	Dorset horn ¹	1958/59	Unknown	Shrestha & Pradhan 1995
	Romney ¹	1958/59	Unknown	Shrestha & Pradhan 1995
	Romney marsh ¹	2014	New Zealand	www.nagariknews.com (2 sept-2014)
	Coopworth ¹	2014	New Zealand	Shrestha & Pradhan 1995
	Rambouillet ¹	1958/59	Europe	Shrestha & Pradhan 1995
	Border leicester			Rijal & Paudel 2011

Scientific Name	Common name	Year of Introduction	Country of origin	Reference
Family: Suidae				
Pigs				
<i>Sus scrofa</i> Linnaeus, 1758	Landrace ¹	1950s	Europe and USA	Shrestha & Pradhan 1995
	Hampshire ¹	1950s	Europe	Shrestha & Pradhan 1995
	Yorkshire ¹	1950s	USA	Shrestha & Pradhan 1995
	Tamworth ¹	1960s	Unknown	Shrestha & Pradhan 1995
	Fa Yuen ¹	1960s	Unknown	Shrestha & Pradhan 1995
	Saddleback ¹	1960s	Unknown	Shrestha & Pradhan 1995
	Duroc ¹	1950s	Unknown	Shrestha & Pradhan 1995
	Wild boar ²	1970s*	Russia	HMG/N 1995
Family: Camelidae				
Alpaca				
<i>Vicugna pacos</i> Linnaeus, 1758	Alpaca ¹	1997	Peru	Subedi 2000
Order: Lagomorpha				
Family: Leporidae				
Rabbit				
<i>Oryctolagus cuniculus</i> (Linnaeus, 1758)	Angora ¹	1988	Turkey	Neopane <i>et al.</i> 1992, Neupane <i>et al.</i> 2010
AVES				
Family: Phasianidae				
Chicken				
<i>Gallus gallus</i> Linnaeus, 1758	New hampshire	1960s	USA	Shrestha & Pradhan 1995
	White leghorn ¹	1960s	USA	Shrestha & Pradhan 1995
	Australorp ¹	1970s	Australia	Shrestha & Pradhan 1995
	Giriraja ¹	1991	India	Sah <i>et al.</i> 2011
	Broiler ¹			FAO, 2014
	Layer ¹			FAO 2014
Anisiformes				
Family: Anatidae				
Duck				
<i>Anas platyrhynchos</i> (Mallard)	Peking duck ¹	1970	Hungary	FAO 1979
	Ng Chow duck ¹	1975	Hong Kong	FAO 1979
Turkey birds				
<i>Melliagris gallapavo</i> Linnaeus, 1758	Turkey ¹	2001	Unknown	Karki 2005, Paudel 2006
Family: Struthionidae				
Ostrich				
<i>Struthio camelus</i> Linnaeus, 1758	Ostrich ¹	2009	Australia	www.ostrichnepal.com
Family: Dromaiidae				
Emu				
<i>Dromaius novaehollandiae</i> Latham, 1790	Emu ¹		Australia	www.ostrichnepal.com

Scientific Name	Common name	Year of Introduction	Country of origin	Reference
Budgerigar				
<i>Melopsittacus</i> sp.	Budgerigar ¹	1990s	Unknown	Baral per.comm
FISH				
Order: Anguiliformes				
Family: Clariidae				
<i>Clarias batrachus</i> (Linnaeus, 1758)	Philippine catfish ²	Unknown	Indonesia	Budha 2013
<i>Clarias gariepinus</i> (Burchell, 1822)	African catfish ²	1996-97	Africa	Budha 2013
Order: Cypriniformes				
Family: Cyprinidae				
<i>Barbonymus gonionotus</i> (Bleeker, 1849)	Silver barb ³	Unknown	SE-Asia	Budha 2013
<i>Ctenopharyngodon idella</i> (Valenciennes, 1844)	Chinese grass carp ¹	1965/66	China	Bista <i>et al.</i> 2011
<i>Cyprinus carpio</i> Linnaeus, 1758	Common carp ¹	1979	E-Asia	Gurung <i>et al.</i> 1994
<i>Cyclocheilichthys apogon</i> (Valenciennes, 1842)	Beardless barb ³	Unknown	Myanmar Indonesia	
<i>Hypophthalmys molitrix</i> (Valenciennes, 1844)	Silver carp ¹	1967/68	China	Bista <i>et al.</i> 2011
<i>Hypophthalmys nobilis</i> (Richardson, 1845)	Big-head carp ¹	1971	China	Bista <i>et al.</i> 2011
<i>Carassius auratus</i> (Linnaeus, 1758)	Goldfish ³	Unknown	E-Asia	Budha 2013
<i>Carassius carassius</i> (Linnaeus, 1758)	Crucian carp ¹	Unknown	Europe	Budha 2013
<i>Labeo bata</i> (Hamilton, 1822)	Minor carp ³	Unknown	India, Bangladesh	Rema Devi & Ali, 2013 http://www.fao.org/fishery/introsp/9061/en
Order: Siluriformes				
Family: Pangasidae				
<i>Pangasius hypophthalmus</i> (Sauvage, 1878)	The iridescent shark ¹	Unknown	Bangladesh, India	Gurung 2013, GoN2014
Order: Cyprionodontiformes				
Family: Poecilidae				
<i>Gambusia affinis</i> (Baird & Girard, 1853)	Mosquito fish ¹	1994	N America	Shrestha 1994, Budha 2013
Order: Perciformes				
Family: Cichlidae				
<i>Oreochromis mossambicus</i> (Peters, 1852)	Mozambique tilapia ²	1985	Africa	Pantha 1993, Shrestha 1994
<i>Oreochromis niloticus</i> (Linnaeus, 1758)	Nile tilapia ²	1985*	Africa	Pantha 1993, Shrestha 1994, Husen 2014
<i>Xenotilapia longispinis</i> Poll, 1951	Cichlid ³	NA	Africa	http://www.fao.org/fishery/introsp/2776/en
Order: Salmoniformes				
Family: Salmonidae				

Scientific Name	Common name	Year of Introduction	Country of origin	Reference
<i>Oncorhynchus mykiss</i> (Walbaum, 1792)	Rainbow trout ²	1971, 1988	N America UK, Japan	Rai <i>et al.</i> 2005, Swar 2008
<i>Oncorhynchus rhodurus</i> Jordan & McGregor, 1925	Japanese amago ¹	1975	Japan	Pantha 1993, Sharma 2008
<i>Salmo trutta</i> Linnaeus, 1758	Brown trout ¹	1969	UK	Rai <i>et al.</i> 2005, Swar 2008
ARTHROPODS				
Class: Crustacea				
Order: Decapoda				
Family: Palaemonidae				
<i>Macrobrachium rosenbergii</i> (De Man, 1879)	Giant freshwater prawn ¹	1986, 1999	Thailand	New 2009
Class: Insecta				
Order: Diptera				
Family: Agromyzidae				
<i>Liriomyza huidobrensis</i> Blanchard, 1926	S-American leaf miner ²	Unknown	Argentina	Paneru & Giri 2011
Family: Tephritidae				
<i>Dacus (Didacus) ciliates</i> Loew, 1862	Ethiopean melon fly ²	1978	Africa	Kapoor & Malla 1979, Kapoor 2005
<i>Carpomya pardalina</i> Bigot, 1891	Baluchistan melon fly ²	Unknown		Kapoor 2005
<i>Bactrocera (Paratridacus) diversa</i> (Coquillett, 1904)	Guava fruit fly ²	Unknown		Kapoor 2005
<i>Bactrocera (Daculus) oleae</i> (Rossi, 1790)	Olive fruit fly ²	Unknown		Kapoor 2005
<i>Bactrocera (Zeugodacus) caudate</i> (Fabricius)	Fruit fly ²	Reported in 1976	Indonesia	Kapoor & Malla 1979
<i>Procecidochares utilis</i> Stone, 1947	Gall fly ¹	1963	New Zealand	Kapoor & Malla 1978, Singh 2004
Order: Homoptera				
Family: Aphididae				
<i>Ceratovacuna lanigera</i>	Sugarcane wooly aphid (SWA) ²	Unknown		Joshi & Viraktamath 2004
<i>Eriosoma lanigerum</i> (Hausmann, 1802)	Wooly apple Aphid (WAA) ²	1962		CIE 1975, Subedi & Pradhan 2012, Paneru & Giri 2011
Family: Diaspididae				
<i>Quadraspidiotus perniciosus</i> Ferris, 1938	San Jose acale ²	1962	India	CABI 2009, Budha 2013
Family: Margarodidae				
<i>Icerya purchasi</i> Maskell, 1878	Australian cottony cushion ²	Unknown	Australia	Hill 1993
Family: Psyllidae				
<i>Heteropsylla cubana</i> Crawford, 1914	Ipil-ipil (<i>Leucaena</i>) psyllid ²	1987		FAO 2007

Scientific Name	Common name	Year of Introduction	Country of origin	Reference
Order: Coleoptera				
Family: Chrysomelidae				
<i>Zygogramma bicolorata</i> Pallister, 1953	<i>Parthenium</i> Defoliator ¹		Probably India	Shrestha 2011
Order: Hymenoptera				
Family: Aphelinidae				
<i>Aphelinus mali</i> (Haldeman, 1851)	Wooly apple aphid parasite ¹	1978	Europe	Joshi <i>et al.</i> 1991
Family: Apidae				
<i>Apis mellifera</i> Linnaeus, 1758	European honey bee ²	1990s	India	Verma 1992
Family: Formicidae				
<i>Paratrechina longicornis</i> (Latreille, 1802)	Longhorn crazy ant	1956	SE Asia ?	Wetterer 2008
Family Braconidae				
<i>Apanteles subandinus</i> Blanchard, 1947	PTM parasitoid ³	2009-10	Peru	Rana 2014
<i>Orgilus lepidus</i> Muesebeck, 1967	PTM parasitoid ³	2009-10	Peru	Rana 2014
Family: Encyrtidae				
<i>Copidosoma koehleri</i> Blanchard, 1940	PTM parasitoid ³	2009-10	Peru	Rana 2014
Order: Lepidoptera				
Family: Bombycidae				
<i>Bombyx mori</i> Linnaeus, 1758	The silkworm ¹	1969		World Bank 1983
Family: Gelechiidae				
<i>Phthorimaea operculella</i> Zeller, 1873	PTM ²	1966	India	NARC 1967, Joshi 1989, 2004
MOLLUSCS				
Class: Gastropoda				
Order: Stylommatophora				
Family: Achatinidae				
<i>Achatina fulica</i> (Bowdich, 1822)	African giant land snail ²	1930s-40s	Africa	Raut 1999, Budha & Naggs, 2008
Family: Streptaxidae				
<i>Gulella bicolor</i> (Hutton, 1834)	Two-toned gulella ¹	Unknown	India	Budha <i>et al.</i> 2015
Family: Agriolimacidae				
<i>Deroceras leave</i> (O. F. Müller, 1774)	The marsh slug ¹	Unknown		Budha <i>et al.</i> 2015
Order: Systelommatophora				
Family : Veronicelidae				
<i>Laevicaulis alte</i> (Férussac, 1822)	Tropical leatherleaf ²	Unknown		Budha <i>et al.</i> 2015

Scientific Name	Common name	Year of Introduction	Country of origin	Reference
Order: Caenogastropoda				
Family: Ampullariidae				
<i>Pomacea canaliculata</i> (Lamarck, 1819)	The golden apple snail ³	Potential		Joshi 2005
Family: Viviparidae				
<i>Filopaludina sumatrensis</i> (Dunker, 1852)	Sumatran river snail ³	Unknown		Irikov & Beckev 2011
<i>Viviparus</i> sp.	Pond snail ³	Unknown		Irikov & Beckev 2011
Order: Hygrophila				
Family: Lymnaeidae				
<i>Pseudosuccinea columella</i> (Say, 1817)	American ribbed fluke snail ³	Unknown		Irikov & Beckev 2011
Family: Planorbidae				
<i>Planorbarius corneous</i> (Linnaeus, 1758)	Great ramshorn ³	Unknown		Irikov & Beckev 2011
PLATYHELMITHES				
Class: Turbellaria				
Order: Tricladida				
Family: Geoplanidae				
<i>Platydemus manokwari</i> De Beauchamp, 1963	New Guinea flatworm ²	Unknown	New Zealand	New report

Note: 1= Introduced species/breed, 2= invasive species, 3= Introduced alien/invasive species status not known