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INVERTEBRATE ANIMALS

INVERTEBRATE ANIMALS IN IRAN, AFGHANISTAN, AND NEIGHBORING CENTRAL ASIA. This category includes all animals without a vertebral column. Thus it is a term of convenience that, though widely used, has little biological meaning. Well over a million species are known, and probably several times that many are unnamed and undescribed. The most species-diverse phylum is the Arthropoda (q.v.), of which the insects (q.v.) are by far the most numerous. Mollusks (snails, clams, squid, etc.) constitute the next largest phylum. These two phyla contain most of the economically important invertebrate animals, but the flatworms (Platyhelminthes) and the roundworms (Nemetoda) include many important parasites of humans, domestic stock, and crop plants. Because so many nematodes are host-specific, and because they are parasites of all organisms, they may turn out to be the most numerous in terms of species. As noted above, most animal species remain to be named and described; this is true of those in Iran, Afghanistan, and neighboring countries as it is worldwide. There is not universal agreement about the number of animal phyla (the most inclusive categories), but Brusca and Brusca (2003) list 33. The single-celled Protozoa are not treated here. In modern taxonomies they are usually removed from the Animal Kingdom and placed in Kingdom Protista.

Most of the literature on Iranian, Afghan, and Central Asian invertebrates deals with insects. These animals have been covered in the article on insects (also see Abivardi, 2001), which will not be discussed here. The remainder of publications dealing with the invertebrates of our area is widely scattered and not easily summarized, but some of the more important items are listed in the

bibliography, along with a few general references that will guide the reader to more literature. The general characteristics of the invertebrate phyla can be found in any recent textbook on invertebrate zoology, such as Brusca and Brusca (2003) or Buchsbaum, Pearce, and Buchsbaum (1999). Fossil invertebrate history is covered in such works as that of Boardman, et al. (1987). There are currently many websites that provide entry into the research and popular literature of various phyla and lower taxa. A few of these are listed at the end of the bibliography.

The major groups of invertebrate animals (exclusive of insects) that are important in the natural history of Iran, Afghanistan, and adjoining Central Asia are listed in Table 1, with a reference code to Section 2 of the Bibliography. Invertebrates inhabit almost every conceivable environment; broadly speaking, we can distinguish marine (Caspian Sea, Persian Gulf), freshwater (ponds, lakes, rivers, and streams), terrestrial, and estuarine environments. They are also parasitic on all invertebrate and vertebrate species, aquatic and terrestrial.

Terrestrial environments. Terrestrial environments are dominated by arthropods, almost to the exclusion of other phyla; and among the arthropods insects are, by far, the most numerous and diverse. However, there are also important species of gastropod mollusks (snails and slugs) in some habitats, and oligochaete annelids (earthworms) are components of soil ecosystems.

Many different terrestrial habitats can be distinguished, such as soil, leaf litter, other ground surfaces, various heights of vegetation, aerial (flying insects), etc. Consideration of the invertebrate faunas within such habitats is beyond the scope of this article, and literature dealing specifically with Iranian and Afghan invertebrate ecology is scanty. Most that does exist deals with insects. Because Iran, Afghanistan, and adjacent Central Asia have large arid areas, some exclusively terrestrial groups of arthropods found in such areas are particularly interesting.

Ticks and mites are numerous and diverse. Ticks are obligate ectoparasites of terrestrial vertebrates and are vectors of various diseases of humans and animals (e.g., relapsing fever, Crimean-Congo Haemorrhagic Fever). Mites may be ectoparasitic on animals, herbivores on plants, free-living predators, or scavengers, and some are aquatic.

Spiders are found in all terrestrial habitats, often occurring in large numbers.

All are predators and possess a venomous bite for subduing prey. They feed principally on insects and other arthropods, although a few of the large desert hunting spiders can take small lizards and other vertebrates. Very few are dangerous to humans, although female black widow spiders (*Latrodectus pallidus, L. dahli*) can cause serious, painful envenomation, occasionally (but rarely) fatal. In addition to the Table 1 literature, see the Mozaffarian web site.

Scorpions are of particular interest, as they are venomous, some species causing human fatalities. These are arthropods with a long, flexible post-abdominal appendage with venom gland and injection device (or "stinger") at the end for both defense and for subduing prey. They have crab-like pincers for holding prey animals, mainly insects, but occasionally small lizards or other animals. See Vachon (1966), Vachon and Kinzelbach (1987), and Farzanpay (1988) for a list of Iranian species, their taxonomy, and distribution; Fet (1989) for a catalog of the species of the former USSR; and Vachon (1959) and Kovarík (1993) for Afghan species.

Pseudoscorpions (Pseudoscorpiones) are tiny (1-7 mm) arachnids that in general body shape and possession of pincers resemble scorpions, but lack a post-abdominal venom delivery device. They do have venom in their pedipalps, which are used in overcoming their prey. They are not capable of envenoming humans. Rarely noticed, they live in a wide variety of terrestrial habitats from moist to dry, under rocks, litter, and debris. They prey on small arthropods, such as mites. A curious aspect of their behavior is their mode of distribution by clinging to the legs of larger arthropods, feathers of birds, and hair of mammals. Thus, many species are widely distributed.

Solpugids are arachnids (Order Solpugida) that occur in arid regions. They are superficially spider-like in appearance, but have large, prominent chelicerae (biting mouthparts). They are aggressive hunters, some of them large enough to take small lizards as well as large insect prey. They are also known as sun spiders, camel spiders, or tarantulas (in the Old World), *roteyl* in Persian. They are widely believed to have deadly venom. Nonetheless, they actually have no venom; and, while capable of delivering a powerful and painful defensive bite, they pose no threat to humans, much folklore to the contrary notwithstanding.

Harvestmen (Opiliones) are arachnids that are not well known in this area. Unlike in spiders, the head and thorax are not clearly separated. They have round, small bodies and four pairs of very long legs. They produce a repugnant odor from glands to repel predators. They occur primarily in damp

forest areas under leaf litter and in gardens, where they feed on small insects and other invertebrates and scavenge dead organic matter. They have no venom, and they do not spin webs.

Millipedes (Diplopoda) are detritus feeders having many body segments with two pairs of appendages per segment. They are primarily inhabitants of moist habitats, being found in leaf litter and loose soils.

Centipedes (Chilopoda, *Scolopendra* spp.), some of large size, occur in Iran. These arthropods are venomous, but human deaths after *Scolopendra* bites are rare, and the data for fatalities appear weak against analysis. Venom generally produces only local effects (burning, swelling, and necrosis) without serious consequences. The greatest threat is to infants and children.

Crustaceans, which dominate aquatic environments, are represented in terrestrial habitats only by isopods, called sow bugs, wood lice, or pill bugs (Schmalfuss, 1986, 1988) and amphipods. Both are most abundant in moist habitats, in and under leaf litter and soil. Terrestrial isopods are primarily scavengers, feeding on decaying plant and animal material, but may also damage living plants. Terrestrial amphipods are also scavengers, sometimes called grass shrimps by gardeners. A number of species inhabit beach areas, where they are called scuds, beach hoppers, or beach fleas.

A number of terrestrial snails and slugs (Mollusca: Gastropoda: Pulmonata) are known from Iran, Afghanistan, and neighboring Central Asia. Many terrestrial snail-species are known as transmitters of zoonotic parasites. Some of these snails, such as Enids, Helicellids, and Succineids, occur in Iran and are important for public health, veterinary medicine, and zoology. The terrestrial malacofauna of Iran is not completely known. A list of the known species has been prepared by Mansoorian and Edlinger (2001).

Earthworms (Annelida: Oligochaeta) are soil organisms, most common and diverse in moist habitats. They pass quantities of soil through their digestive systems, extracting the organic nutrients. As a consequence of their burrowing and feeding, they aerate soil and participate in the decomposition and recycling of nutrients.

Freshwater invertebrates. The faunas of freshwater streams and lakes are dominated by aquatic insects and crustaceans. Among insects, the aquatic larval stages are the most ecologically important, and the species composition

depends on substrate, grade, and flow of the stream or river or the depth, temperature, and turbidity of the lake. Much the same holds true for other invertebrates as well. Invertebrate populations serve as food resources for aquatic vertebrates, fish, frogs, and birds. Invertebrates that live in seasonal lakes and streams have mechanisms for existing through the dry periods by burrowing into bottom sediments and becoming dormant, entering diapause in the egg stage or some other stage of the life cycle, even dehydrating, maintaining minimum cellular functions while inactive, or repopulating the body of water from an outside source.

The following groups of invertebrates (other than insects) are common in freshwater environments: Phylum Cnidaria, hydras, live in unpolluted ponds and lakes; they have a sac-like body of two cell layers, with a single opening rimmed with tentacles. Phylum Rotifera, rotifers or wheel animalcules, are tiny animals found only in freshwaters; a wheel-like rotation of cilia draws in water and food; they are often in commercial feed given to larval fish in aquatic culture, hence exotic species are frequently introduced. Phylum Bryozoa, moss animals, live in encrusting colonies in still water. Phylum Annelida: Oligochata, worms, as in terrestrial habitats feed in decaying organic matter; Annelida: Hirudinea, leaches, are most familiar as bloodsuckers on other animals; there are also scavenging and predatory species; Platyhelminthes: Turbellaria, e.g., planarians, are free-living, feeding on small animals, living or dead; other flatworms are familiar as internal parasites, such as flukes and tapeworms.

Phylum Arthropoda: Ostracoda, seed shrimps, are tiny scavengers that superficially resemble clams; many species are parthenogenetic, i.e., lay eggs that develop without fertilization; Anostraca, fairy shrimps, appear irregularly in ponds or temporary pools, swim on their backs, and produce dense populations; Notostraca, tadpole shrimps, have many pairs of broad swimming appendages, crawl and burrow into fine silt of small ponds and temporary pools; Conchostraca, clam shrimps, have a bivalved “shell” held closed by a strong muscle; Cladocera, water fleas, are abundant in the water column of all freshwaters; some change shape with the seasons; feeders on algae, microscopic organisms, and detritus, they are important food for small fishes; Copepoda, copepods, are ubiquitous in aquatic habitats; they feed on algae, bacteria, and organic debris; Isopoda, isopods, are primarily scavengers on dead vegetation on pond bottoms; Amphipoda, scuds or side-swimmers, are scavengers on organic debris; they avoid bright light; Decapoda, crabs and

crayfish: a single species of crayfish, *Astacus leptodactylus* occurs in Iran, two in Turkmenistan, none in Afghanistan; Arachnida: Acari, water mites, dependent on surfacing for air, are active foragers, feeding on worms, small crustaceans, and insects; some are active swimmers.

Phylum Mollusca: Gastropoda, snails, feed mainly on aquatic plants, though some scavenge dead animals; they feed with a unique rasping "tongue," called a radula; some species are intermediate hosts for internal parasites that cause human and livestock diseases, such as schistosomiasis; Bivalvia: clams, filter feeders, whose larvae, glochidia, live for a time as parasites on the gills of fishes. Phylum Nemertea, proboscis worms or ribbon worms, have a soft, flat body and an extendable proboscis longer than the body; they feed on small animals and algae. Phylum Nematoda, round worms, are tiny worms usually abundant in bottom mud and sand, moving with a whip-like motion; some are predatory, many feed on plants, and virtually all larger animals harbor species of nematodes as parasites. Phylum Nematomorpha, horsehair worms, common in quiet waters in summer; these long, slender worms resemble activated horsehairs and are often tangled together in masses; the larvae are parasitic in mollusks, crustaceans, and insects, particularly crickets and grasshoppers. Phylum Gastrotricha, gastrotrichs, are microscopic animals attached to bottom debris by secretions from a tail appendage; they are primarily algae-feeders. Phylum Tardigrada, water bears, are microscopic animals that superficially resemble four-legged animals; they live among sand grains of beaches and on plants in fresh waters. When ponds dry, they shrivel and remain dormant until moisture is again available; they feed on plants.

Plankton. The plankton is made up of plants (phytoplankton) and animals (zooplankton) that inhabit the water column of all aquatic environments. Although they may be motile, their transport from one area to another is determined by currents, and they may be limited to water masses of particular densities, temperatures, depths, etc. Many species of most of the major phyla have planktonic larvae that, upon maturity, become active swimmers or bottom dwellers, some of them sessile. The plankton is the greatest mass of the food chain, these small plants and animals feeding many animals at higher trophic levels.

Marine environments. Some phyla, notably the echinoderms (sea stars, sea urchins, sea cucumbers), are confined to the marine environment. All phyla are represented in marine environments, and most are more diverse there than in other habitats. As in terrestrial habitats, arthropods are dominant in

terms of species diversity, but it is the crustaceans, rather than the insects, that vastly outnumber all other taxa.

Persian Gulf. Perhaps the most thorough summary of Gulf habitats, ecology, and organisms is the study edited by Krupp et al. (1996), evaluating the effects of the Gulf War in association with establishing a marine wildlife sanctuary north of Jubail. The information pertains to many areas of the Persian Gulf. The cited references in this book make up a useful bibliography to invertebrates and ecology of this marine area. A work on the principal biotopes of the Gulf is that of Basson et al. (1977). For lists of species, keys, and illustrations for identification, and statements of distribution, see Jones (1986). For further references on the animals and environments of the Persian Gulf, see Paldi (1968) and Farmer and Docksey (1983). See the series *Fauna of Saudi Arabia* (1, 1979, through 20, 2004; renamed *Fauna of Arabia* with 17, 1998) for articles on many specific taxa of the Persian Gulf.

The habitats and biotic communities of the Persian Gulf were studied following the Gulf War and the resulting oil spills of 1991. A considerable number of reports and papers were published as a result, and many of these contributed to basic knowledge of Gulf invertebrates. See for example Abuzinada and Krupp (1994a and 1994b), Apel (1994), Apel and Türkay (1992), Downing and Roberts (1993a, 1993b), and Richmond (1994).

Among the interesting marine environments of the Gulf are coral reefs, dominated by the biomass of corals and sponges, and the mangrove swamps, which serve as nurseries for the young of many marine organisms. Both are habitats easily damaged by human activities, particularly coastal development and oil spills (IUCN/UNEP, 1988; Price, 1993; Downing and Roberts, 1993a, 1993b).

Mangroves consist of several species of trees and shrubs having aerial roots. They catch sedimentary runoff from the land and serve as an ecological/geographical boundary between coastal terrestrial environments and shallow marine environments. As sediments accumulate, they extend seaward, extending the land margins over time. Mangroves have been declining in area due to the impacts of unplanned coastal development, with only about 90 km2 remaining off Iran (Dutrieux and Martin, 1989; Price, 1993).

Coral reefs occur mainly as numerous patch reefs. However, fringing reefs are found around offshore islands. Coral species diversity is low in the Gulf (55-60

species) compared with warmer and tropical seas. Brown (1979) provided a brief general description of coral reefs of Abu Dhabi, which would serve as well for other Gulf reefs. Coral polyps (Phylum Cnidaria) deposit a rock-like calcium material (coral) around themselves, and each coral colony develops into a distinctive specific formation, often inhabited by millions of polyps. The crown of each polyp has a ring of stinging tentacles, which are used in capturing minute crustaceans and other animals. Depending on species, the polyps vary from 1 mm to 20 cm in diameter. In Abu Dhabi, three major species, staghorn coral (*Acropora* sp.), brain coral (*Diploria* sp.), and star coral (*Goniastrea* sp.) make up about 90 per cent of the reefs. Reef-building corals depend on a symbiosis with a unicellular alga (zooxanthellae) which lives within the cells of the polyps. These algal cells carry out photosynthesis, which contributes to the productivity of the reef. For this symbiosis to function, light for photosynthesis is necessary, hence coral reefs cannot live in turbid waters, water of heavy sediment loads, or at depths much below 100 meters. Water temperatures above 20o C are required.

Seagrasses occur in shallow (less than 10 m) coastal areas and form the basis for many food chains. More than 530 species of plants and animals were recorded among seagrasses in the Gulf. Studies suggest these seagrass beds support production of 2 million kg of fish annually at a 1987 value of US $10 million, or the same quantity of shrimp (Crustacea, Decapoda) worth US $12 million (Price et al., 1993).

Coastal mudflats are areas where fine-grain sediments have been sorted and deposited in the intertidal area. They form the habitat for many burrowing animals, such as crabs, clams, and polychaete worms. The base of the food chain is organic detritus, broken down by small animals and by microbial decomposers into basic nutrients exported to the marine environment (Apel, 1994; Apel and Türkay, 1992; Clayton, 1983).

Caspian Sea. Zinkevich (1963) recorded 397 invertebrates from the Caspian, not including parasitic organisms; 46 percent are endemic to the Caspian Sea, 66 percent also live in the neighboring southern seas, 4.4 percent are of Atlantic and Mediterranean origin, and 3 percent are of Arctic Ocean origin. Birshteina et al. (1968) have provided a synopsis of the invertebrates of the Caspian Sea along with a bibliography. This treatise contains lists of species, and keys and illustrations for identification. Most of the studies of Caspian invertebrates have been carried out by Russian scholars throughout the 19th and 20th centuries. Birshteina et al. (1968) list the following phyla and

included classes from the Caspian Sea: Porifera (sponges—Demospongia), Cnidaria (Hydrozoa), Platyhelminthes (flatworms), Nemertea (ribbon worms), Entoprocta, Nematoda (roundworms), Rotiferia, Annelida (Polychaeta—bristleworms, Oligochaeta, Hirudinida—leeches), Arthropoda (Crustacea, Insecta), Mollusca (Bivalvia—clams, mussels, Gastropoda—snails), Bryozoa (moss animals). The zooplankton in the Caspian has representatives of Arctic, Mediterranean, and endemic species, a total of 315, made up of *Rotatoria* (135) *Cladocera* (50), *Copepoda* (43), *Mysidacea* (20), *Cumacea* (18), *Amphipoda* (73), and total *Crustacea* (236) (Dumont et al., 1997; Dumont, 1998). See also Mordukhai-Boltovskoi (1979).

Lake Orumiyeh (or Urmia). Iran has a number of areas of internal drainage, i.e., with no outlet to an ocean. These basins contain hypersaline lakes, many of which are dry except for periods of high precipitation and stream runoff. The largest permanent lake of this type is Lake Orumiyeh. It supports a single aquatic alga (*Enteromorpha intestinalis*) and a single invertebrate, the endemic brine shrimp, *Artemia urmiana* (Phylum Arthropoda: Crustacea: Branchiopoda: Anostraca). These two organisms nonetheless form the base of a food chain that supports a diverse migratory and breeding bird fauna. In fact, Lake Orumiyeh is the largest natural habitat of *Artemia* in the world (Van Stappen, et al., 2001).

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