Insect Biology

What are Insects?

Insects are a class of small animals belonging to a large group of **invertebrates** (animals without backbones) called the **arthropods**. The word arthropod comes from two Greek words "arthro" and "poda" which loosely translated means jointed limbs. Having jointed limbs separates the arthropods from other invertebrates such as snails and worms which don't have legs. Another feature common to all arthropods is that they have a hard external skeleton or **exoskeleton** which they wear like a knight's suit of armor to protect their internal organs. Table 1 shows several arthropods which you are likely to see in the Marianas.

Table 1. Examples of insects and insect relatives you are likely to see in the Marianas.

Phylum	**Arthropoda**				
Class	**Arachnida**	**Crustacea**	**Diplopoda**	**Chilopoda**	**Insecta**
Common Groups	spiders, scorpions, mites, ticks	crabs, lobsters, amphipods, sowbugs	millipedes	centipedes	beetles, flies, wasps, moths
Examples	 **garden spider**	 **hermit crab**	 **millipede**	 **centipede**	 **hover fly**
Examples	 **scorpion**	 **land crab**			 **preying mantis**
Examples	 **dog tick**	 **sowbug**			 **swallowtail butterfly**

Insect Diversity: How Many Kinds of Insects are There?

More than half of all the **species** (different kinds of life forms) on our planet are insects. **Entomologists**, scientists who study insects, think that there may be as many as 30 million species of insects. Only a small part, about 1 million of these have been collected and described. To get an idea of how many insect species there are compared to other animals, have a look at the pie chart in Figure 1. Locate the small segment with the fish in it. The size of this piece represents the **chordates** or animals with backbones. This group contains all of the organisms we commonly refer to as "animals": all the mammals, birds, reptiles, amphibians, as well as all the fish. Now compare this to the segment for just one group of

insects, the beetles. The insects do not have to wait for a catastrophe such as a nuclear war to take over the world, they already did so millions of years ago.

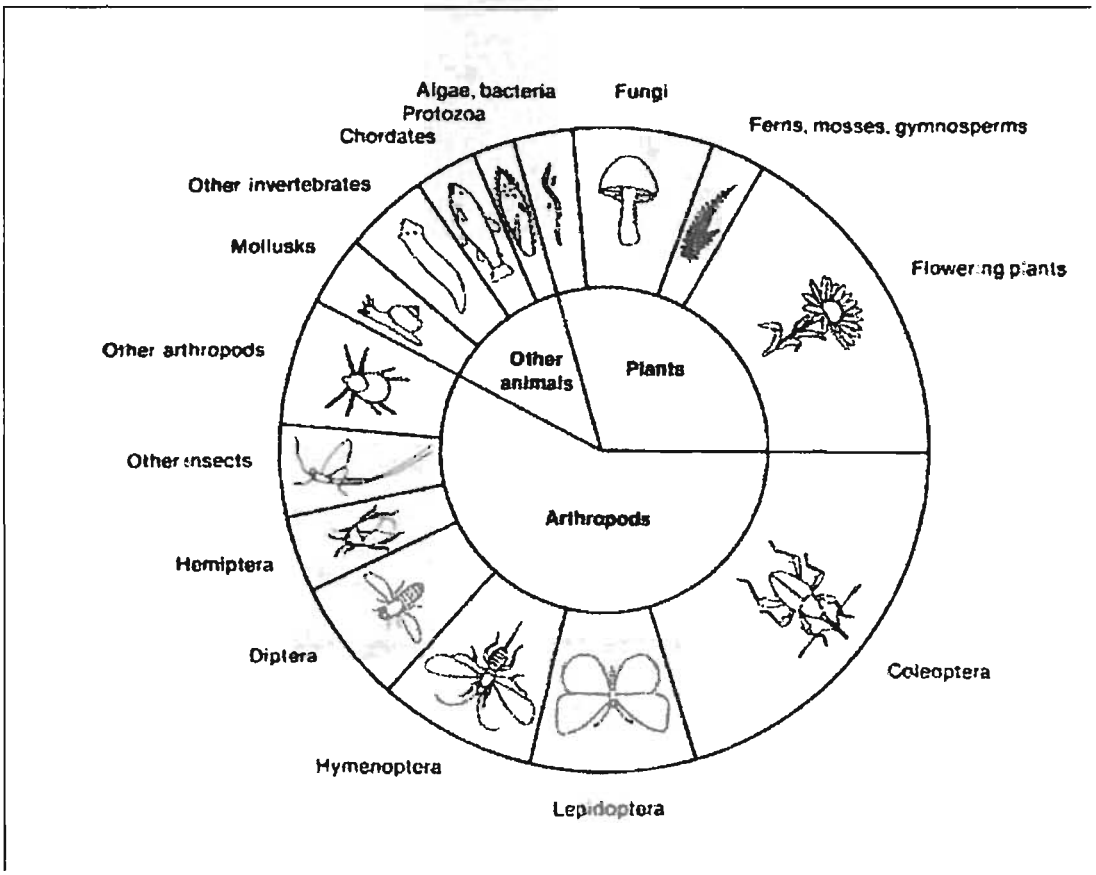

Figure 1. Relative numbers of arthropods, other animals, and plants. Each degree equals 4,200 species. [From (Daly 1978)

Although insect **species diversity** on a global scale is mind boggling, there are relatively few species on our small islands. (Gressitt 1954) estimated that there are "only" about 10,000 species of insects in all of Micronesia with about 2,000 of these occurring on Guam. Table 2 shows how many insect species have been collected on Guam for each major group or **order**. Note that only about half of the estimated number of insect species on Guam have been collected. Insects in the Northern Marianas have not been collected as extensively as on Guam, but the number of species in each order is probably similar to what is found on Guam.

Table 2. Number of insect species in each order collected on Guam. Data from Gressitt 1954.

Insect Order	Common Names	Species Collected
Coleoptera	beetles	260
Lepidoptera	butterflies; moths	240
Diptera	flies	230
Hymenoptera	wasps; bees	150
Hemiptera	true bugs	99
Homoptera	aphids; psyllids; scales; whiteflies; mealy bugs	95
Thysanoptera	thrips	25
Orthoptera	grasshoppers; crickets; roaches	24
Psocoptera	booklice	18
Mallophaga	bird lice	12
Odonata	dragonflies; damselflies	11
Neuroptera	lacewings; antlions	6
Apterygota	silverfish	6
Isoptera	termites	4
Dermaptera	earwigs	4
Anoplura	sucking lice	3
Siphonaptera	fleas	3
Trichoptera	caddisflies	1
TOTAL		**1191**

There are two reasons for the relatively low number of insects in the Marianas. First of all, our small islands do not have as many different habitats as larger islands and continents. In general, the smaller the island, the fewer the species. For example, imagine going on an insect collecting trip to a little offshore sandbar with a single coconut tree growing on it. There are basically only two habitats here, sand and coconut tree. You will probably collect only a few species of insects: those that live in coconut trees, and those that live by eating stuff washed up on the sand. The second reason why we don't have more insect species is **geographical isolation**. On islands, insects and other organisms either **immigrate** from elsewhere, or **evolve** from these immegrants, over millions of years, into new, local forms called **endemic species**. (Gressitt 1954) estimates that **endemicity**, that is the proportion of species that evolved on our islands, is about 45%. There are many species of insects on our islands that do not occur anywhere else in the world.

The rate of immigration of new species was very slow for millions of years after the formation of the Mariana Islands about 45 million years ago because this island chain is surrounded by thousands of miles of open ocean. When the early Chamorros arrived about 3,500 years ago, they undoubtedly brought many new insect species along with their personal belongings, plants, and animals. In the past 500 years, many new species have been carried here with cargo on ships. However, as we will see later, the immigration rate of new species has risen very sharply within the last few decades due to the frequent arrival of jet aircraft.

Insect Morphology: What do Insects Look Like?

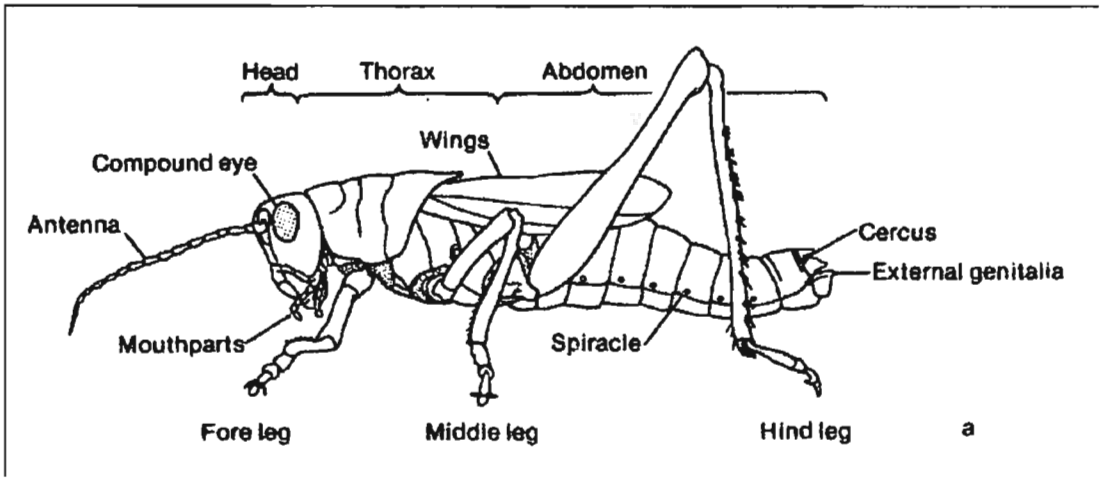

Figure 2. Insect body parts. From (Daly 1978).

Because there are so many different types of insects, it is very hard to come up with a general description of their **morphology**, or what they look like. The following description is a good one for most adult insects. Insects have three major body parts: head, thorax, and abdomen (Figure 2).

Head

The head contains the eyes, antennae, and mouthparts. Most insects have large **compound eyes** which they use to see images of their surroundings. Many also have two or three simple eyes called **ocelli** located on the tops of their heads. Ocelli do not produce images. They simply sense how much light there is. Some people refer to insect **antennae** as feelers. However, their main function is to smell and taste chemicals in the environment. Insects use their antennae to locate food sources. Some insects communicate with others of their species by producing special chemical scents called **pheromones** which are sensed by the antennae.

There are several kinds of insect mouthparts. Dragonflies, mantids, grasshoppers, beetles, caterpillars, ants and wasps have **chewing mouthparts**. Unlike humans who chew with an up and down motion, insect **mandibles**, or jaws, operate side to side to bite off chunks of food and grind them up before swallowing. Other insects have mouthparts that are modified into a **sucking** or a **piercing and sucking** tube. Butterflies and moths suck their food through a long, coiled tube called a **proboscis**. Mosquito and aphid mouthparts work like tiny hypodermic needles that pierce an animal or plant so that liquid food can be sucked out. Houseflies have **sponging** mouth parts to dab up such delightful substances as liquefied manure and decaying plant and animal material before sampling our fiesta plate.

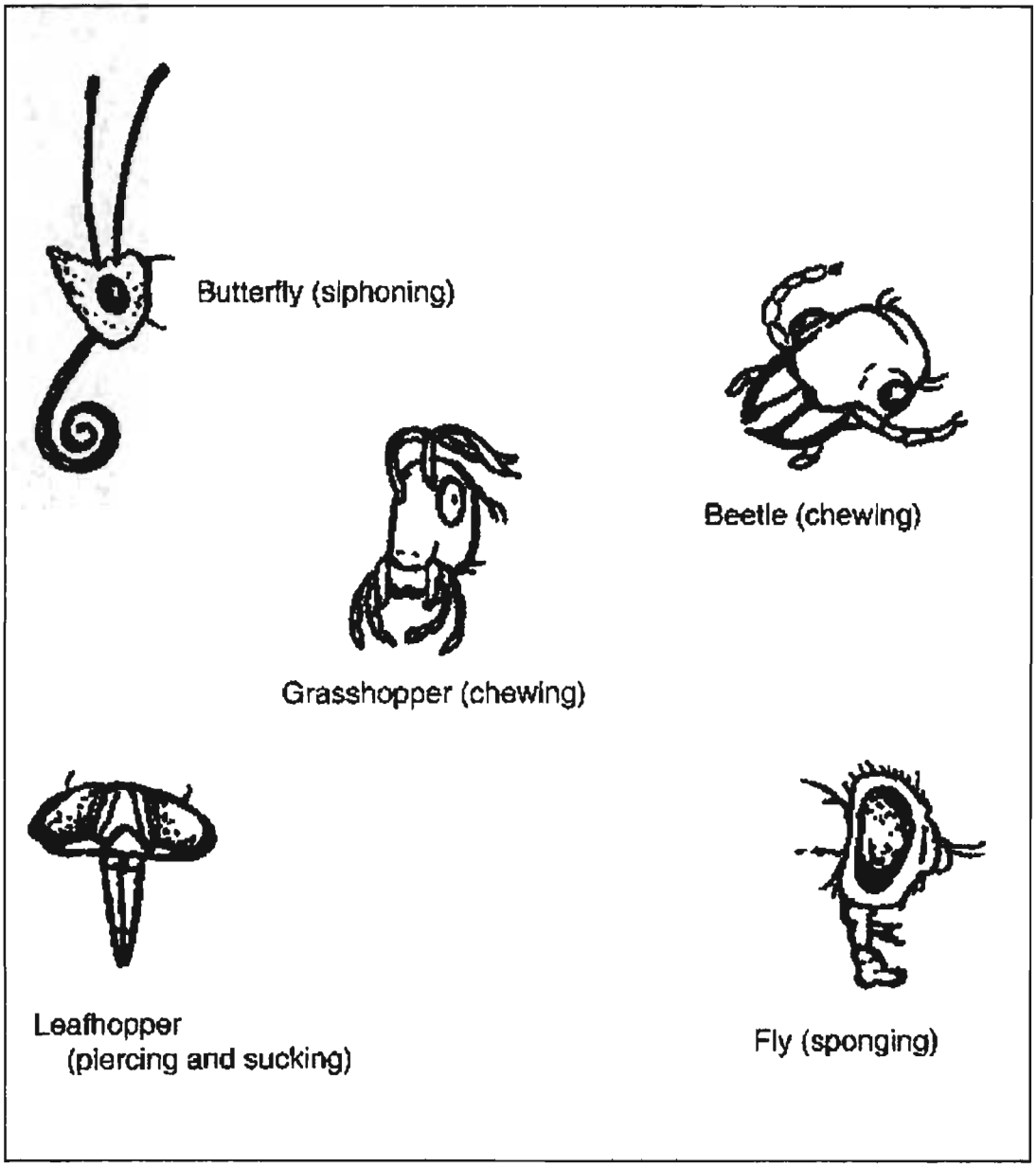

Figure 3. Different kinds of insect mouthparts.

Thorax

The thorax contains three pairs of segmented legs, and usually one or two pairs of wings. Legs may be modified for crawling, jumping, digging, or catching prey. The last leg segment of the leg, the insect's foot, is called a **tarsus**. The tarsus is equipped with claws to hold onto things and chemical sensors which are used to "taste" whatever the insect is standing on. Insect wings are different from those of birds and bats in that they are not modified forelimbs. Most winged insects, except for the flies, have two pairs of wings. Flies have only one pair: the hind wings of flies have been modified into club shaped structures called **halteres**. (The scientific name for flies is Diptera (di=two; ptera=wings)). Only adult insects have

wings. Those little houseflies you see are not baby flies. They are adults and they will not grow any bigger.

Abdomen

The abdomen contains the digestive and reproductive organs. External reproductive organs are called **genitalia**. Female genitalia are often modified into a long, pointed egg laying tube called an **ovipositor**. In some species of Hymenoptera (bees, wasps, and ants), the ovipositor has been modified into a **stinger** used for defense and for paralyzing or killing prey. Because only females have ovipositors, males cannot sting. Some insect abdomens have a pair of appendages called **cerci** which are used as feelers (cockroach) or pinchers (earwig).

Insect Classification

Because there are so many different kinds of plants and animals, scientists have devised a system of classification. The process of giving a name to a plant or animal is called **taxonomy**. The taxonomic hierarchy for the honey be is as follows:

KINGDOM Animalia (animals)

PHYLUM Arthropida (arthropods)

CLASS Insecta (insects)

ORDER Hymenoptera (ants, wasps, bees)

FAMILY Apidae (honey bees, bumble bees)

GENUS Apis

SPECIES ***mellifera***

Figure 4. Honey bee (*Apis mellifera*).

The scientific name for the honey bee is ***Apis mellifera***. Scientific names are the genus and species written in Latin, once regarded as the universal scientific language. All scientific names are unique and are accepted and understood by biologists worldwide. The honeybee has many common names, but only one scientific name. Insects within the same species are able to mate and reproduce. Insects are grouped into higher **taxa**: genus, family, and order based on morphological similarities. Taxonomists look for similarities and differences in mouthparts, wing venation, numbers of tarsal segments, and other morphological characters when deciding in which group to put different species. Taxonomy is not an "exact science". For example, some taxonomists place roaches, mantids, and termites in an order called Dictyoptera, while others place roaches and mantids with the grasshoppers and crickets in order Orthoptera, and put termites in their own order, Isoptera. It can get very confusing!

Insect Life Cycles

Insects change form or **metamorphose** as they grow from egg to adult. In order to grow, insects must shed their exoskeletons. This process is called **molting**, and most insects molt several times as they grow. Insects with **incomplete metamorphosis** have three life stages. Eggs hatch into **nymphs**, also called **naiads** if they are aquatic (such as dragonflies). Nymphs look like miniature adults and usually, but not always, feed on the same food as the adults. Insects with **complete metamorphosis** have an additional life stage and the young do not resemble the adult. Eggs hatch into larvae that grow and molt several times. When fully grown, the larvae molt into the **pupal stage**, which allows them to transform themselves into completely different-appearing adults. Lacewings, beetles, butterflies, moths, mosquitoes, flies, bees, fleas, ants, wasps, and others experience complete metamorphosis. Insect larvae have various names, depending on the group to which they belong, such as **grubs** (beetles), **maggots** (flies), **caterpillars** (butterflies and moths), and **wrigglers** (mosquitoes). It is important to note that that most larvae do not rely on the same food source as the adults. Thus, if the insect is a pest, damage to our crops or to us usually occurs during only one stage of the insect's life.