Chapter VII —Order Trichoptera

(Caddisflies)

- (Williams & Feltmate, 1992)
  - Superphylum Arthropoda
    - (jointed-legged metazoan animals [Gr, *arthron* = joint; *pous* = foot])
  - Phylum Entoma
  - Subphylum Uniramia
    - (L, *unus* = one; *ramus* = branch, referring to the unbranched nature of the appendages)
  - Superclass Hexapoda
    - (Gr, *hex* = six, *pous* = foot)
  - Class Insecta
    - (L, *insectum* meaning cut into sections)
  - Subclass Ptilota
  - Infraclass Neopterygota

The Trichoptera (caddisflies) belong to the infraclass Neoptera, division Endopterygota; their wings develop internally instead of externally in wingpads. They are closely related to the Lepidoptera (butteflies and moths), an insect order with very few aquatic species. The larvae of all the species of Trichoptera are aquatic, except for a few cases.

The wings of Trichoptera are covered with setae, from which the name of the order is derived (from the Greek “trichos”= hair, and “pteron”= wing).

Three superfamilies have been distinguished, which include five groups based on case-building behaviour. Hydropsychoidea (Hydropsychidae, Philopotamidae, Polycentropodidae, and Psychomyiidae) are the net spinners and retreat makers; Rhyacophiloidea include the free-living forms (Rhyacophilidae), saddle-case makers (Glossosomatidae), and purse-case makers (Hydroptilidae); and Limnephiloidea are the tube-case makers.

Life History

Caddisflies are holometabolous insects whose eggs are deposited in gelatinous matrices in or out of water. Larvae go through 5 instars (rarely 6 or 7). Most species are univoltine, but some complete more than 1 generation per year, whereas others require 2 years for development. The pupal phase is generally 2 to 3 weeks, although some species may overwinter as pupae. Many caddisflies undergo a diapause phase, which, depending on the species, occurs in one of several life history stages. Pupae have functional mandibles that they use to chew their way out of the pupal case once they are ready to emerge as adults. Adults are mostly crepuscular, limiting their activity to dusk or darkness. Adults live from a few weeks to several months, depending on the species and the nature of the habitat.

Mass emergences of some species from large rivers are considered a nuisance by residents, since the insects are attracted to outdoor lights; human allergies to the scales on their wings have also been reported. The larvae of some leptocerids are reported to damage the young shoots of rice plants in paddy fields. The larvae of a few species are known to eat fish eggs. On the beneficial side, many hydropsychids prey on black fly larvae.

Many species that inhabit temporary ponds lay eggs in the basins of dry pools in the fall, when the soil surface is beginning to become more moist. After larvae hatch, they may remain within the gelatinous matrix for months until the pool basin is reflooded. Moisture is the apparent stimulus for larvae to break out of the gelatinous matrix and begin case building or net spinning.

Adult caddisflies differ from moths in a number of aspects foremost amongst which are patterns of wing venation and structure of the mouthparts. Adult caddisflies are small (1.5 mm body length) to moderate-sized (4.0 cm), tend to be drab in colour, and are mostly active at night, especially around lights. During the day they hide in riparian vegetation. The compound eyes are well developed and there may be up to three ocelli. The mouthparts are weak and are capable only of ingesting liquids. All three thoracic segments are distinct. The legs are long and slender.

Caddisfly larvae are quite similar to lepidopteran caterpillars but have only a single pair of abdominal prolegs which are located on the terminal segment and are each equipped with an apical anal claw. The larval thorax is well developed, with at least the pronotum covered dorsally by a pair of sclerotized plates.

The trichopteran pupa is exarate and, in case-building species, develops within the larval case after it has been secured to the substrate and sealed with silk. In free-living species, the final instar larva builds a special pupal case, generally made from silk and mineral particles, again this is firmly attached to the substrate. In most species, the pupa is equipped with heavily sclerotized mandibles which enable it to cut an opening in the case so that it may escape and swim to the water surface.

Habitat and Distribution

Like mayflies and stoneflies, caddisflies probably evolved in cold, fast-flowing streams, since families with more primitive characteristics (e.g., Rhyacophilidae) are restricted to those habitats. It has been hypothesised that the use of silk for case construction enabled the Trichoptera to become more diverse ecologically, providing a respiratory mechanism whereby habitats with higher temperatures and lower dissolved oxygen levels could be exploited.

At present, caddisflies inhabit a wide range of habitats from the ancestral cool streams to warm streams, permanent lakes and marshes, and permanent and temporary ponds. One species has been found in tide pools off the coast of New Zealand; the females oviposit through the papillar pores of starfishes. Caddisflies have been generally classified as clingers, sprawlers, or climbers, although a few are burrowers.

Although caddisfly larvae are found in a wide range of aquatic habitats, the greatest diversity occurs in cool running waters. Furthermore, in families represented in both lotic and lentic habitats, the genera exhibiting more ancestral characters tend to be found in cool streams whereas those showing more derived characters tend to occur in warm, lentic waters. These two findings point to cool, running waters as the most likely primordial caddisfly habitat, the one in which the ancestors of the Trichoptera first became aquatic and the one in which differentiation into the basic groups (superfamilies) took place (Williams & Feltmate, 1994).

Table VII-1: Distribution of the families of Trichoptera, together with typical larval habitats (Williams & Feltmate, 1992)

Family	Distribution and Habitat
Rhyacophiloidea	
Rhyacophilidae	All major zoogeographical zones except Australian, Neotropical, Afrotropical & the Antarctica; in cool running waters
Hydrobiosidae	Mainly confined to Australian & Neotropical regions; running waters
Glossosomatidae	Cosmopolitan; running waters
Hydroptilidae	Cosmopolitan; running & standing waters
Hydropsychoidea (Net-spinning caddisflies)	
Philopotamidae	Cosmopolitan; running waters
Stenopsychidae	Oriental, Australian, Afrotrop. & Asian Palaearctic regions; fast-flowing rivers
Hydropsychidae	Cosmopolitan; running waters & wave-swept shores of lakes
Polycentropodidae	Cosmopolitan; running & standing waters
Dipseudopsidae	Afrotropical & Oriental regions (1 genus in the Nearctic); lakes & slow-flowing waters
Ecnomidae	All regions except the Nearctic; lakes, ponds & slow-flowing waters
Psychomyiidae	All regions except Australian & Neotropical; cool running waters, some in lakes
Xiphocentronidae	Afrotropical, Oriental, Neotropical & extreme south of Nearctic (Mexico, Texas); small streams
Limnephiloidea (Tube-case-building caddisflies)	
Phryganeidae	Confined to Nearctic, Palaearctic & Oriental regions; mainly lakes & marshes, slow-flowing streams, temporary pools
Phryganopsychidae	Himalayas & China to Japan, Korea & adjacent Siberia
Brachycentridae	Confined to Nearctic, Palaearctic & Oriental regions; running waters (cool streams to large rivers, depending on genus)
Limnocentropodidae	Oriental Region & Japan; rapid streams
Chathamiidae	Restricted to Australian Region; embryogenesis takes place in coelom of starfishes, larvae become free living in coastal waters (marine)
Tasimiidae	Australian & Neotropical regions only; clear mountain streams
Limnephilidae	Mostly in cooler parts of Nearctic & Palaearctic, some in adjacent Oriental, some in temperate Neotropics (Dicosmoecinae), a few in Australian & Afrotropic regions; most types of running & standing waters, including temporary & brackish waters
Goeridae	All regions except Australian & Neotropical; running waters, especially spring seeps
Thremmatidae	Confined to southern Europe; cold mountain streams
Uenoidae	Western North America, Japan & Himalayas;

Family	Distribution and Habitat
	rapid streams
Lepidostomatidae	All regions except Australian, but in Neotropical only in montane Central America, not South America; mainly slow, cool running waters; littoral of lakes
Oeconesidae	Confined to Australian Region; forested streams, in plant debris
Kokiriidae	Confined to Australian & Neotropical regions; sandy substrates in streams & lakes
Plectrotarsidae	Confined to Australia; larvae unknown
Beraeidae	Eastern Nearctic & European Palaearctic; cool streams, springs & organic muck in spring seeps
Sericostomatidae	All regions except Australian; flowing & standing waters
Conoesucidae	Confined to Australian Region; streams
Antipodoeciidae	Confined to Australia, larvae unknown
Calocidae	Confined to Australia & New Zealand; small forested streams
Helicophidae	Confined to Australia & N.Z.; clear, fast streams
Molannidae	In Holarctic & Oriental regions; sandy substrates in standing or slow-flowing waters
Odontoceridae	All regions, except Afrotropic; running waters
Atriplectididae	Known from Australia & Seychelles; bottom sediments in lakes & slow rivers
Philorheithridae	Confined to Australian & Neotropical regions; cool, rocky streams
Helicopsychidae	Cosmopolitan, but with greater diversity in tropics; cool & warm running waters; littoral zone of lakes
Calamoceratidae	All regions (but sparse), but mainly subtropical; slow streams, coastal lakes, swamps; phytotelmata
Leptoceridae	All regions (abundant); mainly standing waters; slower sections of rivers

A final point worth mentioning about the Trichoptera, in general, and about those that live in small streams in particular, concerns habitat specificity. Many species that are restricted to small streams reflect the ecological characteristics of the surrounding terrestrial community. In such streams, conditions for the larvae are affected by shade in summer or winter, the amount and periodicity of leaf-fall, and the distribution of local precipitation, all three of which are integrated with the type of climax community occupying the general area. As a result, there is, in general, a marked correlation between these terrestrial biomes and the ecological affinities of their respective small-stream caddisfly faunas. Such correlations are of enormous importance to palaeoecology, and caddisfly remains are proving to be a powerful tool in the interpretation and reconstruction of past environments (Williams & Feltmate, 1994).

Feeding

Caddisfly larvae occupy every conceivable trophic level or functional feeding group. Many Limnephiloidea are shredders or grazers, and Hydropsychoidea are characteristically filter feeders or predators, using silken nets to collect seston or catch prey. Caddisflies can also be selective feeders, preferentially removing more-nutritious foods from their nets (algae, animals). Some Limnephiloidea filter feed (Brachycentridae: *Brachycentrus*) by orienting their legs into the current to trap particles suspended in the water column. The saddle- and purse-case makers are specialized algal grazers and can defend territories of rich algal resources or depress algal densities, thereby outcompeting other grazers. The free-living forms and a few of the tube-case makers feed on other insect larvae, crustaceans, or annelids.

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