

Caddisflies (Trichoptera) of Darband River (Iran: Tehran)

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Abstract

Taxonomic classification and detection of new species always had been an interesting subject in science world. Human want to know what's going around his environment; he find new species with new unknown characteristics and uses them in different aspects of life.

In this survey Trichoptera species of Darbad River were determined. It took 4 months from April, with appearing of primitive larva, to July as adults vanished.

The study was done in 3 steps; 1. Geographic searches to find suitable places for sampling, 2. Outdoor experiments and sampling for three groups of Larvae; pupae and adults and 3. Laboratory and taxonomic studies.

Two stations were specified for experiment. Specimens were collected directly by hand or indirectly with a piece of stick from soaked rock underneath for larvae and pupae. Waterside vegetations and rocks were swept for adults which would be captured by a trap, 10% formaldehyde containers and blacklight.

Samples were transmitted to lab in 10% Formaldehyde containers then were moved to 96% Ethanol. Forewing and hindwing venations in addition of male genitalia were perused for taxonomy.

Seven families, 7 Genera and 7 species were identified among 90 collected adults. Two species belonging to *Polycentropodidae*: *Polycentropus*, *Polycentropodidae*: *Holocentropus*. were new and had not been reported before

Determined taxons were: *Lepidostomatidae*: *Dinarthrum chaldyrense*, *Hydrobiosidae*: *Apsilochorema iranicum*, *Philopotamidae*: *Dolophilodes ornate*, *Rhyacophilidae*: *Rhyacophila obscura*, *Hydropsychidae*, *Polycentropodidae*: *Polycentropus*, *Polycentropodidae*: *Holocentropus*. *Hydropsichidae*.

Chapter 1

Introduction

Introduction

I did this project on Caddisflies or Trichopteras of Darband River in Tehran to determine their different types. This was a taxonomic study done at the level of species.

Taxonomy from greek *τάξις*, *taxis*, 'order' + *νόμος*, *nomos*, 'law' or 'science', is the science of naming and classifying. Taxonomy is composed of units known as *taxa* (singular *taxon*) which arranged in a hierarchical structure, related by subtype–supertype relationships, also called parent-child relationships. Subtype and supertype share similar characters or constrains but supertype bears more additional characters. Such arrangement is based on visible or scientifically natural similarities which are defined as identification keys.

Greek philosopher, Aristotle (384-322 B.C.) was the first person attempted to classify organisms but a real classification method which still is using was introduced by Carolus Linnaeus (1707-1778).

There are various taxonomies according to type of base information and manner and units of classification.

In *phylogenetic taxonomy* or *cladistic taxonomy*, evolutionary relationships with shared derived characteristics arrange organisms (clades) in hierarchical trees (Littlewood & Bray 2001).

In *Phenetics*, *numerical taxonomy* or *taximetrics* mathematic defines ranks. The specific morphological characteristics of organisms are digitized to be computed mathematically and put them in different ranks according to their similarities (Ryser & Marth 1999).

Nonscientific or *folk taxonomy* is classifying upon personal methods and parameters without imitating from general scientific laws (Macbeth & Mac Clancy 2004).

The seven main ranks in the obligatory taxonomy or hierarchy are *kingdom*, *phylum*, *class*, *order*, *family*, *genus*, and *species* which drive to lower branches or subgroups.

1-1: Caddisfly (Trichoptera)

Caddisfly or Trichoptera came from Greek trich, "hair" and ptera, "wings" (Fig 1.1) also called sedge-flies, Shad-flies, Periwinkle or rail flies are small moth-like insects having two pairs of hairy membranous wings (Morse 1997). These Holometabolus - complete metamorphosis- insects are closely related to Lepidoptera (moths and butterflies) (Wiggins 2004) and the two orders together form the superorder Amphiesmenoptera.



Fig 1.1: Adult Caddisfly Pycnopsyche species (Volcott 2006)

Caddisflies with aquatic larvae are found in a wide variety of habitats such as streams, rivers, lakes, ponds etc (Kumanski 2001). The larvae of many species construct protective cases composed of gravel, sand, twigs or other debris with silky cement.

The life cycle takes about six months to two year, starts from a gelatinous egg mass, followed by aquatic larval, then pupal stage and ends by mating of adults.

Caddisflies are classified into three suborders including case making caddisflies called Integripalpia, with various types of portable cases, Retreat making caddisflies or Annulipalpia that produce nets or tubes, and free living cocoon making caddisflies or Spicipalpia (Holzenthal et al. 2007).

1-2: Evolution and Paleontology

From paleontology and evolutionary point of view, Trichoptera diverged from Amphiesmenoptera (long extinct) and invaded cool spring streams during the late Triassic period in about 200,000,000 years ago (Short et al. 1992, Beir 2007).

Diversification of Trichoptera dates back to the middle Jurassic (Kristensen 1997, Ivanov 2002) with an explosion in Mesozoic Era (Morse 1983) (Fig 1.2) and case abundance occurred in the Cretaceous (Grimaldi & Engel 2005) (Fig 1.3).

To this day all of the discovered Trichopteran fossils include 7 fossil families, 78 fossil genera and 488 fossil species (Trichoptera world check list 2008).

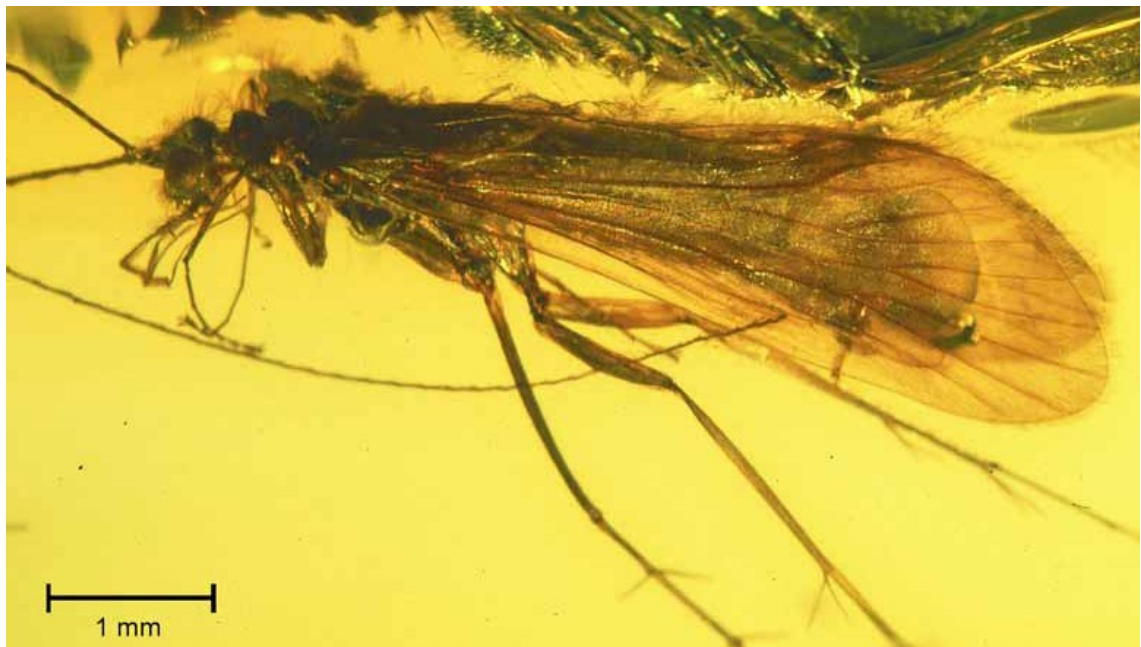


Fig 1.2: Caddisflies fossils in Mexican amber: Male *Plectropsyche alvarezi* (Wichard 2006)



Fig 1.3: Fossil Trichoptera case, Klondike Mountain Formation, 49 million years old, Ferry County, Washington, USA, Size: 17 mm long (Wolkman 2008).

1-3: Egg

Round or elliptical eggs, enclosed in a gelatinous water absorbing matrix (spumaline) are laid as a single mass or string (Chinery 1993) (Fig 1.4). Spumaline swells on contact with water and hatching occurs in few weeks (Hickin 1968).



Fig 1.4: Trichoptera Egg mass (Marcot 2004).

1-4: Larvae

The aquatic larvae vary in shapes and colors according to family type (Huryn 1985, Killips 2005 – 2008) but sharing general features (Fig 1.5).

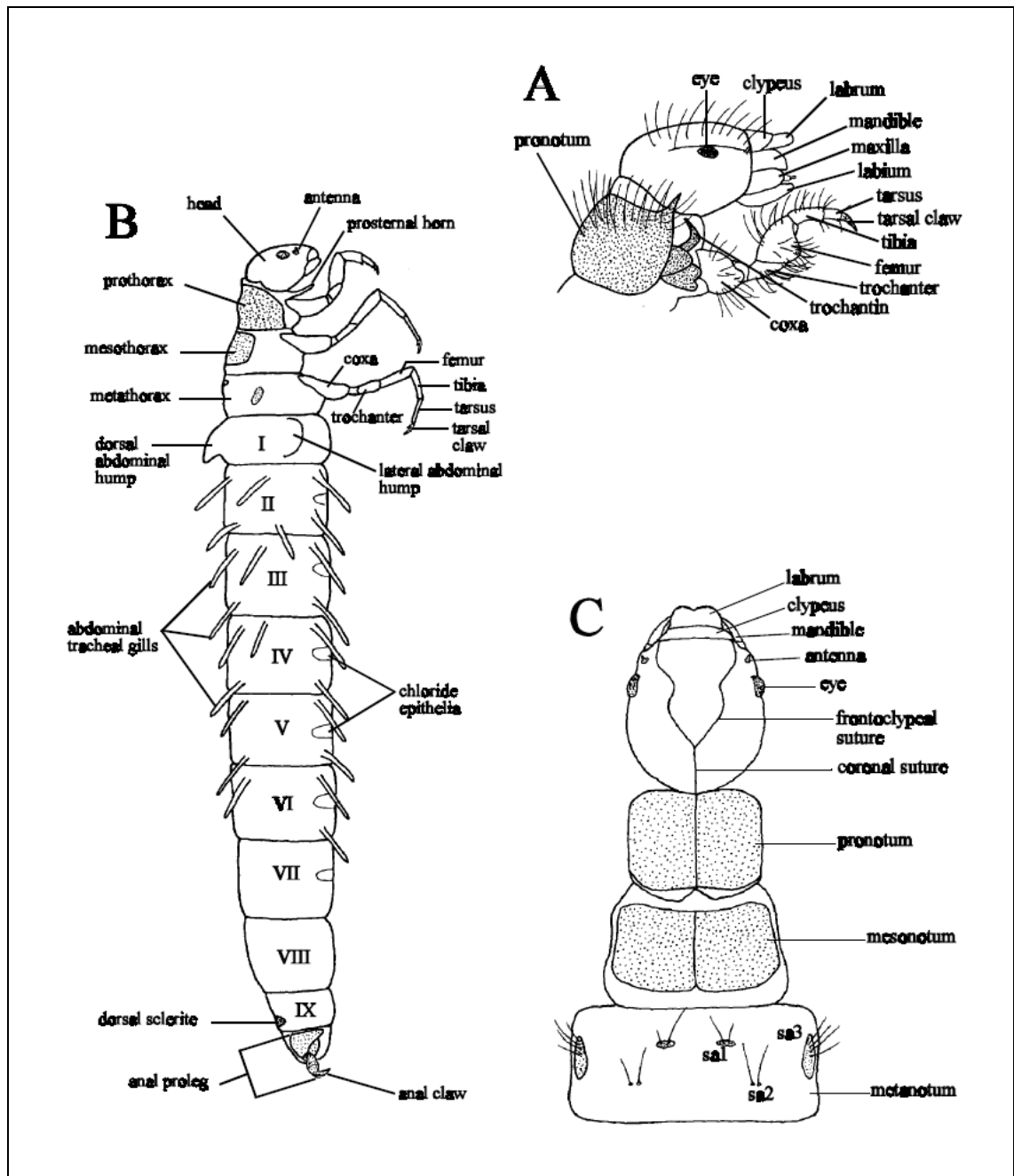


Fig 1.5: General Trichoptera larval feature, A: Head; B: Body; C: dorsal view (Pescador et al. 1995).

The head capsule is sclerotized with a dorsally Y shaped ecdysial line (Pescador et al. 1995). A single eye presents on each side of the head (Wiggins 2004). The antennae are inconspicuous, short with single segment (Morse).

Mouthparts are well developed include a pair of mandibles vary in shapes depending on feeding ways, two short, compact maxilla, short, simple and flap-like labrum and labium with an opening on the tip for emitting of proteinaceous silk secreted by silk glands (Morse 1997).

Thorax segments show different appearances according to family type. Prothorax always bears two sclerotized plates, separated by the ectysial suture (Holzenthal et al. 2007). In some families, membranous fingerlike ventral horn and a pair of lateral trochantin can be seen on protothorax (Borror & Triplehorn 1989). Mesothorax and methathorax may or may not be sclerotized (Wiggins 2004). Setae may be present on the meso- or metanotum.

Each thoracic segment bears a pairs of segmented legs with same length or the forelegs shorter than hind legs (Hickin 1968). In some species the forelegs are modified for predation and in other, hind legs are long and slender, with rows of long swimming hairs for filtering of food particles (Gallepp 1997).

The abdomen has 10 membranous segments (Wiggins 2004). In some families segments bear a few scattered setae. In some such as Integripalpia there are eversible dorsal and lateral humps at the first abdominal segment role in circulating of water through the case (Wiggins 2004, Spellman 2007).

Abdomen lacks legs except the last segments with a pair of modified anal prolegs (Fig 1.6). Each proleg has a strong anal claw using in anchoring to case, with basal setae which differ in number according to families (Wiggins 2004).



Fig 1.6: Anal prolegs and claws of Rhyacophilidae (Koch).

Filamentous gills present in subdorsal, dorsolateral, ventrolateral, and/or subventral rows on abdominal segments singly or in tufts or stalks.

Larvae in case making families construct hard cases protecting them against predation and physical damage. They rebuild their cases in their different instars. Retreat making Caddisfly rebuild, adding or enlarging their cases as they grow (Johnson et al. 2008).

Cases apart from their various shapes are made from gravel, sand, twigs, debris, aquatic plants, algal cells, snail shell etc. (Fig 1.7) which are bound together with secreted silk (Wiggins 2004). Case materials mostly depend on around substrate than family type despite the shapes of cases which are completely family dependent (Duprat 1996).

Annulipalpia build a net to catch the prey and free living Spicpalpia have no case or net (Wiggins 2004).

The position of antennae with eyes, arrangement of setal areas and sclerites, Shape of pronotum, mesonotum, metanotum, existence of trochantin, prosternal horn, lateral and mesal hump, number of basal setae on prolegs and shape of case represent taxonomic keys.

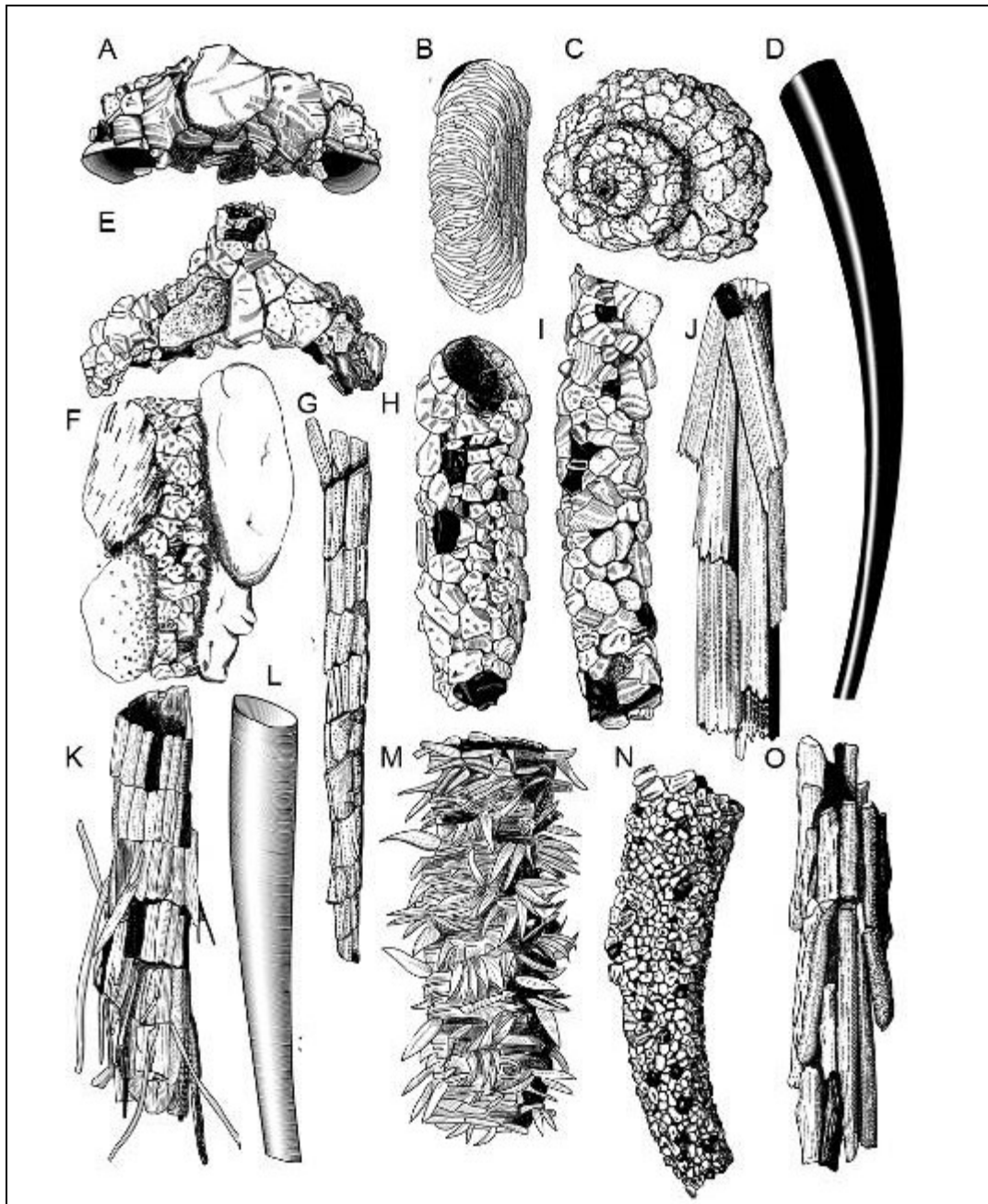


Fig 1.7: Trichoptera larval cases. A–*Culoptila moselyi* (Glossosomatidae); B–*Dibusa angata* (Hydroptilidae); C–*Helicopsyche borealis* (Helicopsychidae); D–*Grumicha grumicha* (Sericostomatidae); E–*Culoptila unispina* (Glossosomatidae); F–*Goera fuscata* (Goeridae); G–*Triaenodes tardus* (Leptoceridae); H–*Discosmoecus* sp. (Limnephilidae); I–*Setodes incertus* (Leptoceridae); J–*Sphagnophylax meiops* (Limnephilidae); K–*Banksiola dossauria* (Phryganeidae); L–*Leptocerus americanus* (Leptoceridae); M–*Phanocelia canadensis* (Limnephilidae); N–*Lepania cascada* (Goeridae); O–*Anabolia bimaculata* (Limnephilidae) (Holzenthal et al. 2007).

1-5: Pupa

Pupas with different colors are known by two very long antennae that sometimes coil around the end of abdomen, strong mandibles to cut the cocoon's case, swimming hairs on legs to come out of water, abdominal paired hook plates to aid pupa exiting, remnant larval gills and loosely attached adultlike legs and wings (Wiggins 2004). General features of pupa are shown in fig 1.8.

Larvae in their last instar make a case consists of small stones lining internally with silky membrane, close case's ends with silky meshwork and attach it to underwater rocks. Abdominal undulation regulate rate of flow water current to provide more oxygenated environment for pupa in case (Borror & Triplehorn 1989).

The site to start pupation depends on some factors such as water depth, current velocity, oxygen content, substrate and existence of other Caddisflies not necessarily same families; therefore we can see a cluster of attached cases in one place. This aggregation protects them from enemies but environment changes also affect them all (Wiggins 2004).

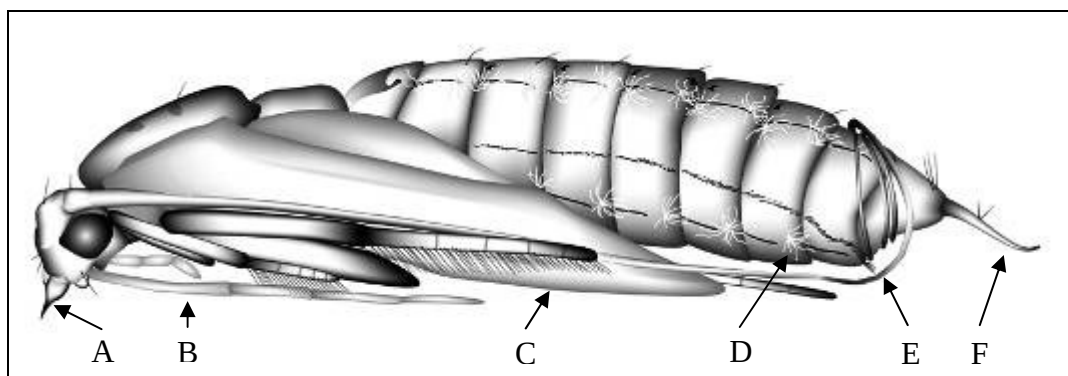


Fig 1.8: General feature of pupa, *Ceraclea* species (Leptoceridae), A: mouth parts, B: Antennae, C: Wing, D: remained larval gills, E: Antennae, F: Tail (Holzenthal et al. 2007).

1-6: Adult

Adult Trichoptera is weak flier terrestrial insect with hairy tentlike wings which are put aside the body at rest (Fig 1.1). Differently colored hairs on the wings and the distinct patterns of colored patches on the wings allow recognition of the species. Body length of adults ranges in 1.5 – 45 mm (Holzenthal et al. 2007). Common feature of adult is delineated below in fig 1.9.

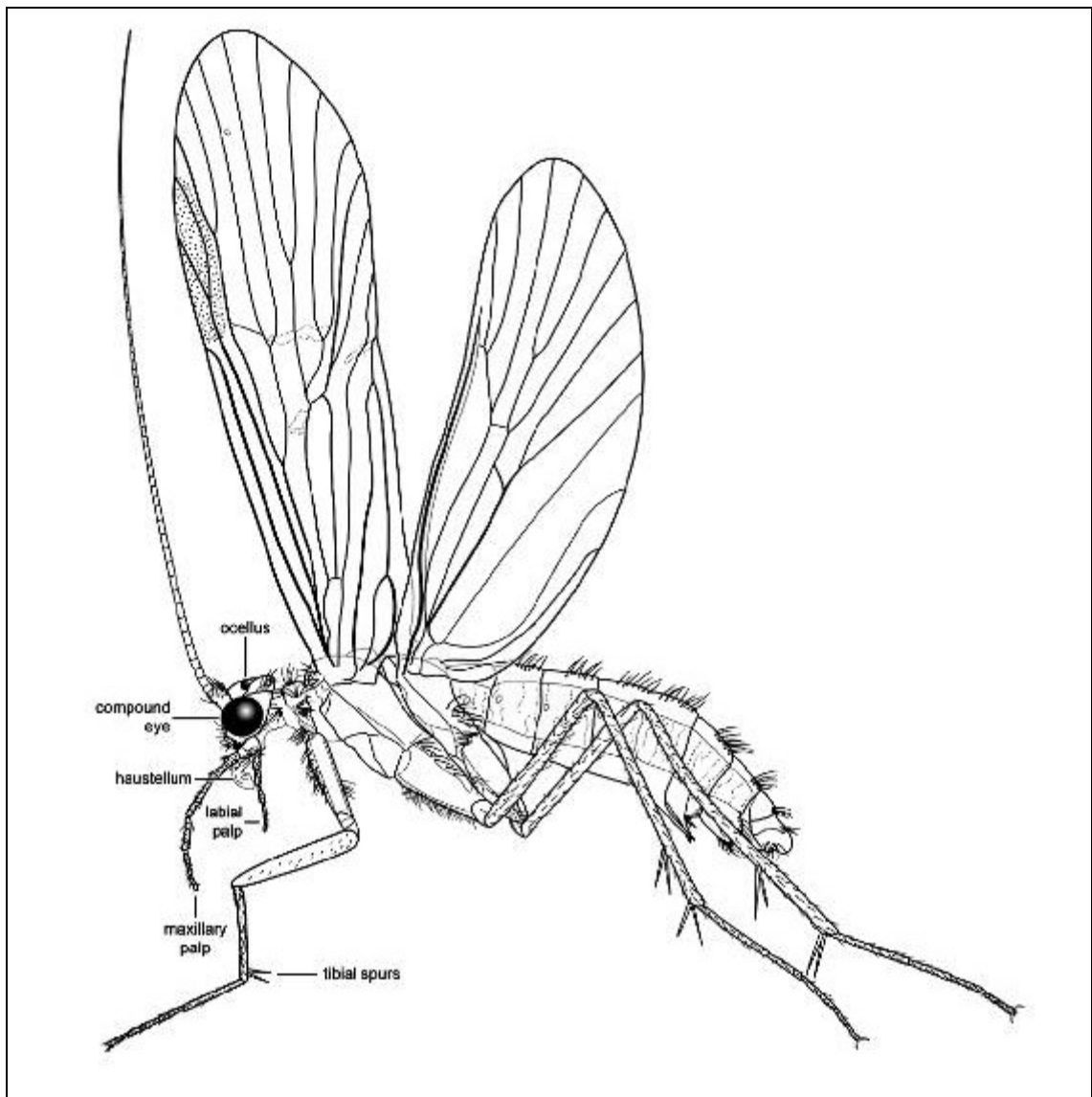


Fig 1.9: Adult Caddisfly of Hydrobiosidae (Chamorro-Lacayo 2004).

Mouthparts are reduced, so, the feeding is limited to liquids (nectar of plants) (Borror & Triplehorn 1989). The mandibles are absent or nonconspicuous but the maxillary and labial palps (sensory appendages) are well developed and composed of 5 and 3 segments. In males of some species, the maxillary palps bear secondary sexual modifications and in only a few species the palps are absent (Wiggins 2004, Holzenthal et al. 2007). The apex of the labium (Prelabium) and the hypopharynx are fused together to form a sucking tongue called *haustellum* (as proboscis) for imbibing fluids which is a unique structure for the order (Morse 1997). The apex of *haustellum* is membranous and has several channels formed from rows of microtrichia (fine hairs) that aid in soaking up water or sugary liquids provided from riparian plants (Grimaldi & Engel 2005).

Various sensory and scent organs may occur on the head or wings. There are two well developed compound eyes in both sides of head which mostly are larger in male (Mafham 1993) with three ocelli in some families (Wiggins 2004).

The mostly filamentous (Filiform) antenna are held straight forward in front of the head at the rest (Chinery 1993) and are about as long as the body or several times longer (Meyer 2005). The basal segment of antenna, called scape, is largest with modified setae, scales, or glandular structures in some males. The pedicel, second segment, is usually short, and the latest segments bear many long conspicuous thread-like flagella (Wiggins 2004).

The tentorium, the internal head skeletal structures, has various shape and complexity which differs among the various families (Holzenthal et al. 2007).

Wings are covered with hair or setae and occasionally with patches and scales (Holzenthal et al. 2004). Forewings are longer but hind wings are broader (Hickin 1968).

Males mostly have secondary sexual modifications on the wings include regions with long tufts of hair or heavily scaled, secondary folds, swelled regions in the membrane and etc. (Holzenthal, et al. 2007). Wing venation is specific for species (Baumgardner & Bowles 2005).

Forewing and hindwing have their own characteristics venation which are basically similar to each other and are considered as one of the major taxonomic keys (Fig 1.10). The major veins are the costa (C), subcosta (Sc), radius (R), media (M), cubitus (Cu), and anal veins (A). These main veins divide

to several further subbranches. They are attached longitudinally with some cross veins forming 3 wing cells including Discoidal cell (DC), Medial Cell (M) and Thyridial cell (TC). Wing branches are numbered as wing forks 1-5.

The 3 anal veins are looping or coalescing anteriorly to form a double-Y configuration as a specific characteristic of Trichoptera.

Hind wing venation is similar to that of forewing, except that is often more reduced, the fork 4 is always absent and all of the anal veins reach the posterior wing margin (Holzenthal et al. 2007).

There are wartlike or tuberlike hairy structures on the dorsal of head and thorax called Setose or Setal, varying in size and number (Olah & Johanson 2007) which are used in taxonomic studies (Borror & Triplehorn 1998, Wiggins 2004).

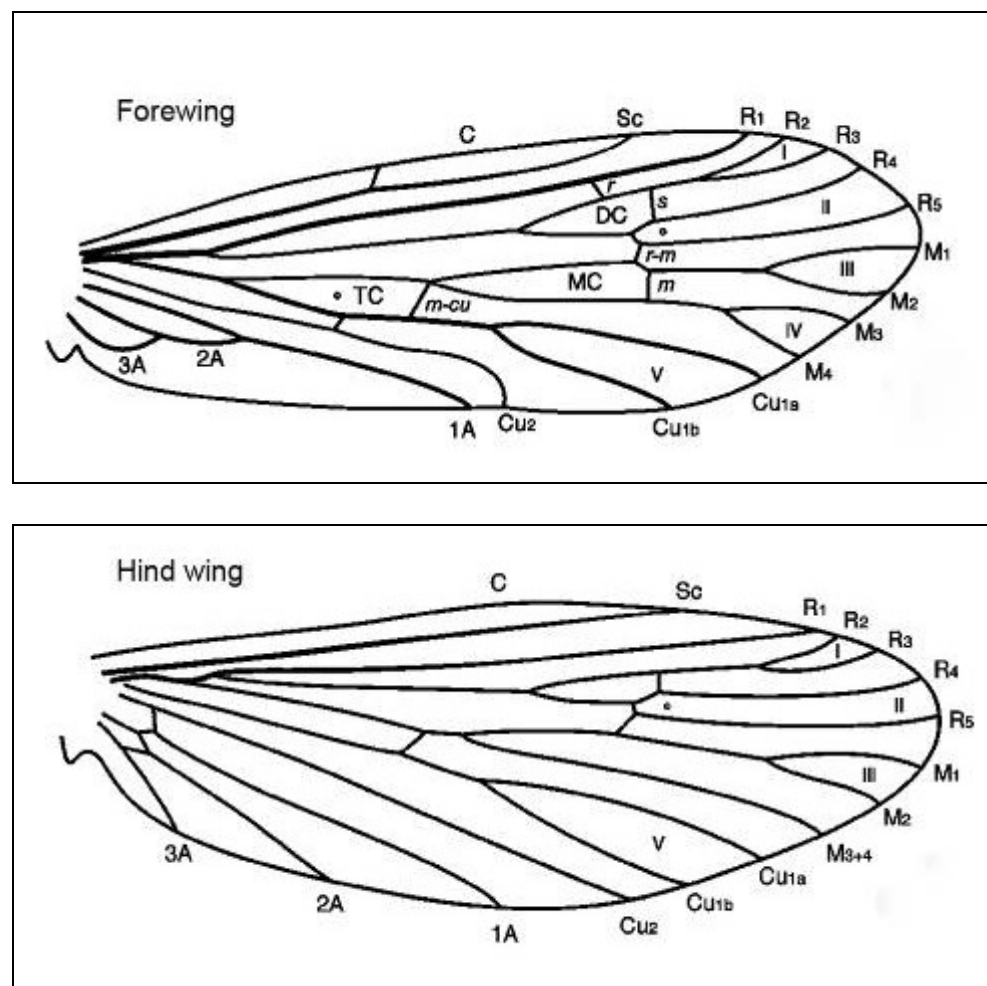


Fig 1.10: Trichoptera wing venation; Forewing and Hind wing (Holzenthal et al. 2007).

Prothorax is small and inconspicuous (Wiggins 2004) and Mesothorax and metathorax carry the wing-bearing pterothorax. Legs are long and slender, with 5 jointed tarsi.

Tibia spurs with different numbering formulation occur at the apex of each segment or at its proximate and are another valuable taxonomic key (Stark 1988, Borror & Triplehorn 1998).

Abdomen shape differs among Trichoptera families especially segment 10 in males which act a basic function in species differentiating (Wiggins 2004, Holzenthal et al. 2007).

Females lack true ovipositor, instead have a protrusible oviscap at the 10th abdominal segment for placing eggs on the substrate or bear a shorter apparatus for forming and holding the egg mass (Spanhoff et al. 2003).

1-7: Reproduction

Sexual communications occur in different ways such as chemical communication by secreting of pheromone, or making auditory signals by moving the wings or visual signals through symbolic dances (Bjostad et al. 2005, Wood & Resh 2005).

Mating occurs internally due to transfer of spermatophores by male and female lays eggs underwater or on waterside vegetations (Wiggins 2004).

1-8: Ecology and habitat

Caddisflies are bioindicator as their high sensitivity to water pollution (Morse 1997). They live in shadowy, well oxygenated, cool, running waters such as lakes, ponds, streams, etc. Their vegetation faunas are reeds, grasses, shrubs and trees (Johnson et al. 2008). The existence, distribution and diversity of them are associated with oxygen level of water, chemical contents, water velocity and clearance of water (Wiggins 2004). Adults are mostly nocturnal and rest on waterside vegetation or rocks during the day (Svendsen et al. 2004).

Larvae control growth of plants and algae by feeding them. Caddisflies are good source of food for aquatic animals (Hafele 2006).

1-9: Feeding

Trichoptera exhibits variety form of feeding in a wide diet collection with different feeding activity levels during life stages from significant feeding in larvae to nonefeeding adult (Neboiss 1977).

The all types of feeding manners include omnivory, carnivory and herbivory can be seen among larvae. Some of them make silky nets to capture prey (Fig 1.11). Pupae use food materials, preserved by larval tissue, and adults feed on plant fluids or flower nectars or are completely non-feeding (Wiggins 2004).

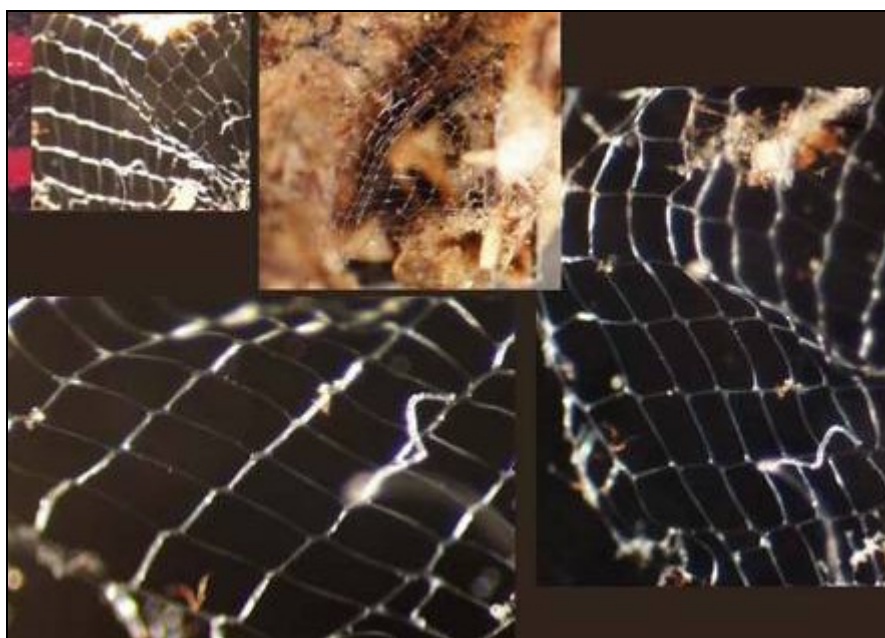


Fig 1.11: Net of Hydropsychidae (Adams 2004)

1-10: Caddisflies of Iran

The number of reported Trichoptera taxa in the world is 76 extant families, 610 Genera and 12627 Species. 60 taxa are belonging to Iran and are shown in table1 (Trichoptera world check list 2008).

Table1: List of caddisflies of Iran (Trichoptera World check list 2008).

Trichoptera (Caddisfly) of Iran							
No.	Taxon	Superfamily	Family	Subfamily	Tribe	Genus	Subgenus
1	<i>Baetis curvi</i>	HYDROPSYCHOIDEA	Baetidae			<i>Baetis</i>	
2	<i>Baetis quadricornis</i>	HYDROPSYCHOIDEA	Baetidae	G. Umer		<i>Baetis</i>	
3	<i>Dolichotritia varia</i>	HYDROPSYCHOIDEA	Hydropsychidae	Dolichotritiinae		<i>Dolichotritia</i>	
4	<i>Cheumatopsyche procuscula</i> (Hydropsyche)	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Cheumatopsyche</i>	<i>Cheumatopsyche</i>
5	<i>Hydropsyche consanguinea</i>	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Hydropsyche</i>	<i>Hydropsyche</i>
6	<i>Hydropsyche demarensis</i> (<i>integrata</i>)	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Hydropsyche</i>	<i>Hydropsyche</i>
7	<i>Hydropsyche spulsi</i>	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Hydropsyche</i>	<i>Hydropsyche</i>
8	<i>Hydropsyche mahmoudi</i>	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Hydropsyche</i>	<i>Hydropsyche</i>
9	<i>Hydropsyche nasdi</i>	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Hydropsyche</i>	<i>Hydropsyche</i>
10	<i>Hydropsyche subarctica</i> (<i>namani</i>)	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Hydropsyche</i>	<i>Hydropsyche</i>
11	<i>Hydropsyche scilignat</i> (<i>quadris</i>)	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Hydropsyche</i>	<i>Hydropsyche</i>
12	<i>Hydropsyche suspensula</i>	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Hydropsyche</i>	<i>Hydropsyche</i>
13	<i>Polycaetropoda subarctica</i> (<i>hepatica</i>)	HYDROPSYCHOIDEA	Polycaetropodidae	Polycaetropodinae		<i>Polycaetropoda</i>	
14	<i>Polycaetropoda maculosa</i>	HYDROPSYCHOIDEA	Polycaetropodidae	Polycaetropodinae		<i>Polycaetropoda</i>	
15	<i>Pseudocentropoda iranica</i>	HYDROPSYCHOIDEA	Pseudocentropodidae	Pseudocentropodinae		<i>Pseudocentropoda</i>	
16	<i>Imides heptis</i>	HYDROPSYCHOIDEA	Psychomyiidae	Imidinae		<i>Imides</i>	
17	<i>Imides chebana</i>	HYDROPSYCHOIDEA	Psychomyiidae	Imidinae		<i>Imides</i>	
18	<i>Imides trituberosa</i>	HYDROPSYCHOIDEA	Psychomyiidae	Imidinae		<i>Imides</i>	
19	<i>Imides parva</i>	HYDROPSYCHOIDEA	Psychomyiidae	Imidinae		<i>Imides</i>	
20	<i>Imides lachrya</i>	HYDROPSYCHOIDEA	Psychomyiidae	Imidinae		<i>Imides</i>	
21	<i>Imides vanderhaeghe</i>	HYDROPSYCHOIDEA	Psychomyiidae	Imidinae		<i>Imides</i>	
22	<i>Phlebotomus schenckii</i>	PHLEBOTOMIDEA	Phlebotomidae	Phlebotominae		<i>Phlebotomus</i>	
23	<i>Wernsdia khorrami</i>	PHLEBOTOMIDEA	Phlebotomidae	Phlebotominae		<i>Wernsdia</i>	
24	<i>Chimarra ziegneri</i>	PHLEBOTOMIDEA	Phlebotomidae	Chimarrinae		<i>Chimarra</i>	<i>Chimarra</i>
25	<i>Athripsodes argenteus</i>	LEPTOCEROIDEA	Lepidoceridae	Lepidocerinae	Athripsodini	<i>Athripsodes</i>	
26	<i>Athripsodes ilici</i>	LEPTOCEROIDEA	Lepidoceridae	Lepidocerinae	Athripsodini	<i>Athripsodes</i>	
27	<i>Selodius divergens</i>	LEPTOCEROIDEA	Lepidoceridae	Lepidocerinae	Selodini	<i>Selodius</i>	
28	<i>Aukia andromedea</i>	LEPTOCEROIDEA	Lepidoceridae	Lepidocerinae	Imidini	<i>Aukia</i>	
29	<i>Imidius zaidi</i>	LEPTOCEROIDEA	Lepidoceridae	Lepidocerinae	Imidini	<i>Imidius</i>	
30	<i>Schizopala persica</i>	SEMPERIDROMIDEA	Semperiidae			<i>Schizopala</i>	
31	<i>Lepidodroma maritima</i> , <i>lucifera</i>	LEPIDODROMIDEA	Lepidodromidae	Lepidodrominae		<i>Lepidodroma</i>	
32	<i>Lepidodroma khorrami</i>	LEPIDODROMIDEA	Lepidodromidae	Lepidodrominae		<i>Lepidodroma</i>	
33	<i>Lepidodroma kuznetzi</i>	LEPIDODROMIDEA	Lepidodromidae	Lepidodrominae		<i>Lepidodroma</i>	
34	<i>Glyptotendipes persicus</i>	LEPIDODROMIDEA	Limnephilidae	Limnephilinae	Limnephilini	<i>Glyptotendipes</i>	
35	<i>Limnephilus tenuis</i>	LEPIDODROMIDEA	Limnephilidae	Limnephilinae	Limnephilini	<i>Limnephilus</i>	
36	<i>Sterophylax persicus</i>	LEPIDODROMIDEA	Limnephilidae	Limnephilinae	Sterophylaxini	<i>Sterophylax</i>	
37	<i>Sterophylax mahani</i>	LEPIDODROMIDEA	Limnephilidae	Limnephilinae	Sterophylaxini	<i>Sterophylax</i>	
38	<i>Sterophylax zarathustra</i>	LEPIDODROMIDEA	Limnephilidae	Limnephilinae	Sterophylaxini	<i>Sterophylax</i>	
39	<i>Agapetus khorrami</i>	GLAUCOSOMATOIDEA	Glaucosomatidae	Agapetinae		<i>Agapetus</i>	<i>Agapetus</i>
40	<i>Glaucosoma agerionum</i> (<i>persicum</i>)	GLAUCOSOMATOIDEA	Glaucosomatidae	Glaucosomatinae	Glaucosomatini	<i>Glaucosoma</i>	<i>Glaucosoma</i>
41	<i>Hydrobia armata</i>	HYDROPTILOIDEA	Hydroptilidae	Hydroptilinae		<i>Hydroptila</i>	
42	<i>Hydrobia atrata</i>	HYDROPTILOIDEA	Hydroptilidae	Hydroptilinae		<i>Hydroptila</i>	
43	<i>Hydrobia hochbergii</i>	HYDROPTILOIDEA	Hydroptilidae	Hydroptilinae		<i>Hydroptila</i>	
44	<i>Hydrobia vachelski</i>	HYDROPTILOIDEA	Hydroptilidae	Hydroptilinae		<i>Hydroptila</i>	
45	<i>Stactobia forzi</i>	HYDROPTILOIDEA	Hydroptilidae	Stactobinae		<i>Stactobia</i>	
46	<i>Stactobia limnai</i>	HYDROPTILOIDEA	Hydroptilidae	Stactobinae		<i>Stactobia</i>	
47	<i>Stactobia marini</i>	HYDROPTILOIDEA	Hydroptilidae	Stactobinae		<i>Stactobia</i>	
48	<i>Stactobia mayeri</i> (<i>deceit</i>)	HYDROPTILOIDEA	Hydroptilidae	Stactobinae		<i>Stactobia</i>	
49	<i>Aplocheorema narsini</i>	HYDROPTILOIDEA	Hydroptilidae	Aplocheorematae		<i>Aplocheorema</i>	<i>Aplocheorema</i>
50	<i>Hydropsyche ibesta</i>	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Hydropsyche</i>	<i>Hydropsyche</i>
51	<i>Hydropsyche burgundi</i>	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Hydropsyche</i>	<i>Hydropsyche</i>
52	<i>Potamyia asenath</i>	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Potamyia</i>	
53	<i>Cheumatopsyche flavella</i>	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Cheumatopsyche</i>	<i>Cheumatopsyche</i>
54	<i>Cheumatopsyche persica</i>	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Cheumatopsyche</i>	<i>Cheumatopsyche</i>
55	<i>Hydropsyche estivalica</i>	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Hydropsyche</i>	<i>Hydropsyche</i>
56	<i>Hydrobia hockeys</i>	HYDROPTILOIDEA	Hydroptilidae	Hydroptilinae		<i>Hydroptila</i>	
57	<i>Imides vorzeli</i>	HYDROPSYCHOIDEA	Psychomyiidae	Imidinae		<i>Imides</i>	
58	<i>Hydropsyche lundali</i>	HYDROPSYCHOIDEA	Hydropsychidae	Hydropsychinae		<i>Hydropsyche</i>	
59	<i>Halesus digitatus</i>	LEPIDODROMIDEA	Limnephilidae	Limnephilinae	Sterophylaxini	<i>Halesus</i>	
60		LEPIDODROMIDEA	Crustidae	Crustinae		<i>Crustus</i>	
61			Hydropsychidae				
62	NEOTRIPALPIA(suborder)	SEMPERIDROMIA	Semperiidae			<i>Cavania</i>	
63			Semperiidae			<i>Notidia</i>	
64			Semperiidae			<i>Cecidius</i>	
65			Semperiidae			<i>Schizostoma</i>	
66			Semperiidae			<i>Schizostoma</i>	

Chapter 2

Materials and Method

2-1: Geographical information of Darband River

Darband River originates from southern Toochal, a part of Alborz Mountains, in north of Tehran (Nomad 2006). Darband River is averagely 4723 meters long and 7 meters wide with 2200 hectares mountainous area. The river is alive all the time but its water level changes during the year. The mountain slope decreases in gravity as it comes close to the castle. This part, up to the Sarband square, is in an average 1500 meters long, 9 meters wide and 6 meters deep with a stony waterbed. River continues to flow in a canal which is about 1000 meters long from Sarband square to the northern angle of the Saad Abad palace. Then it enters the 500 meters long complex of Saad Abad palace (Also Jafar Abad). Most of the river has its natural passages except for 70 meters with a stony wall. The river flows along south part of the Palace in Shahid Jafari Street and joins Golab Dareh down the Tajrish Bridge to form Maqsoud Beik stream. This river passes along Dr. Shariati Street, Elahiyeh, Zargandeh, Davoudiyeh districts and Mother square to reach the junction of Pasdaran, Shariati and Shahid Hemmat highway. The river narrows down in Band Ali Khan Lagoon and disappears in a salty desert land (Micarelli et al. 2007) (Fig 2.1).

Darband Mountain is a popular site for mountain climbing or hiking and for tourists to visit too. Many traditional tea houses and restaurants have been made alongside the river. Chair lifts are available down the mountain at Sarband square.



Fig 2.1: Toochal mountain; Red lines are toochal branches, left to right: 1-Darband sarband route; 2-Routes and sub routes to Spillet area; 3-Golabdarreh route; 4-Jamshidiyeh park route; 5-Darabad routes (Nomad, 2006).

2-2: Sampling stations

The face of Darband River changes from top downward when it meets the urban area. The waterbed and sediments are similar all over but water depth and velocity and vegetation differ through the river. Temperature also increases from upstream downward.

The river is mostly covered with long trees and makes a well shadowy cool habitat for living of caddisfly. The Waterbed is stony and rough. River which is surrounded by bushes, shrubs and trees flows downward with sharp slope in some areas that makes river hard to access and investigate.

At the beginning of my investigation, different parts and branches of river were assessed for existence of larvae in the first month of spring. The final investigation to find sampling stations was done on main branch of river because subbranches had low water level or were without bedside vegetation and Caddisfly larvae.

Two stations for sampling were selected according to larval population. The population and diversity of Caddisfly were on the highest level in these places. They both had rapid running water, rough stony waterbed, tall trees and shrubby riparian vegetation.

Station 1 with area of about 5m * 20m was located at 35°, 50', 31" N; 51°, 25', 30" E; elev 2049m (Fig 2.2, 3).

Station 2 with area of about 10m * 20m was located at 35°, 50', 28" N; 51°, 25', 26" E; elev 2028m (Fig 2.2, 4).



Fig 2.2: Geographical position of stations 1 and 2.



Fig 2.3: Station 1



Fig 2.4: Station 2

2-3: Collecting of specimens

Samples include larva with their cases, pupa and adult were collected from April for 3 months on 9:00am to 8:00pm.

2-3-1: Larvae and cases

Larvae hide within their cases or come out of them during the day. So, cases are also near the site of larvae. Both larvae and cases are tightly attached to beneath surface of rocks in water, log in riffles, vegetation and leaves and can be easily seen with naked eyes if rocks were removed. Not all cases are easy to distinguish. Sometimes larvae and their cases are covered under plant debris and hide from eyes. Larvae and cases were removed with a piece of stick, forceps, clamp or something like them.

2-3-2: Pupa

All of pupae were in their cocoon within sand composed cases and the collecting method was similar to larvae.

2-3-3: Adult

Adults were taken by sweeping, beating, and visual searching of stream side rocks and vegetation during the day, supplemented by a light trap consisting of an 8W F8T5 blacklight fluorescent tube in afternoon.

2-4: Preservation and storage

Newly collected samples were preserved in little bottles containing 10% Formaldehyd to be transferred to lab for further studies then were transmitted to 75-80% Ethanol (Bonada, *et al.* 2004). Bottles were isolated to air.

Genitalia were separated from body and washed with water and KOH 10% to clean abdominal content then were placed in 70-75% Ethanol (Ward 1995, Morse Li & 1997, Bonada, *et al.* 2004).

The final preservation of all specimens was in 96% ethanol.

2-5: Dissection

Dissecting tools for wing and Genitalia were consisted of forceps, dissecting needles, scissor, dissecting containers, e.g. Petri-dishes and watch glasses.

2-6: Slide preparation

Wings were covered with hairs and had to become cleaning to appear venation. Separated wings were put on a Petri dish then were brushed with a fine brush to remove hairs from their surface.

Cleaned wing were put in 80% Ethanol for a couple of minutes then were transported on slide and let to dry. Dried wings were covered with some Glycerol and a cover slip on them and then were sealed with colorless nail varnish.

2-7: Microscopic studies

Samples were studied by a zoom stereo microscope model Olympus SZ61-DP20 and microscope model Olympus CX41-32C02. Larvae, pupa and adult were studied under stereo microscope and provided photos were taken from them with a digital camera model Olympus DP20-BASIC and digital camera model Canon powershot S3.

2-8: Taxonomy

Collected data were checked with reported taxonomic keys by different writers via electronic sources (Papers, books, etc.). Samples of collected specimens were sent to Tricopteroologist Dr. johanson Kjel Arne for final checking of the taxonomic results.

Chapter 3

Results

3-1: Larva

This experiment was started from appearing of primitive larvae in April until disappearing of adults in July.

Primitive larvae were in two general groups including big larvae and small ones. The head and first segments of body were dark in small members while big ones had brown head with lucid body. Little cases composed of pebbles or plant debris were attached to underwater rocks.



Fig 3.1: Primitive larvae

Abundant and diversity of larvae occurred in May. They showed different shapes, colors and sizes. They varied from slime to fleshy, in white, crème, light and dark brown color spectrums and 10-19mm length (Fig 3.2A & B). This diversification revealed their family differentiation.



Fig 3.2 A: Larvae with different shapes and colors. From up: Philopotamidae 10mm, Hydropsychidae 18mm, Hydropsychidae 15mm.

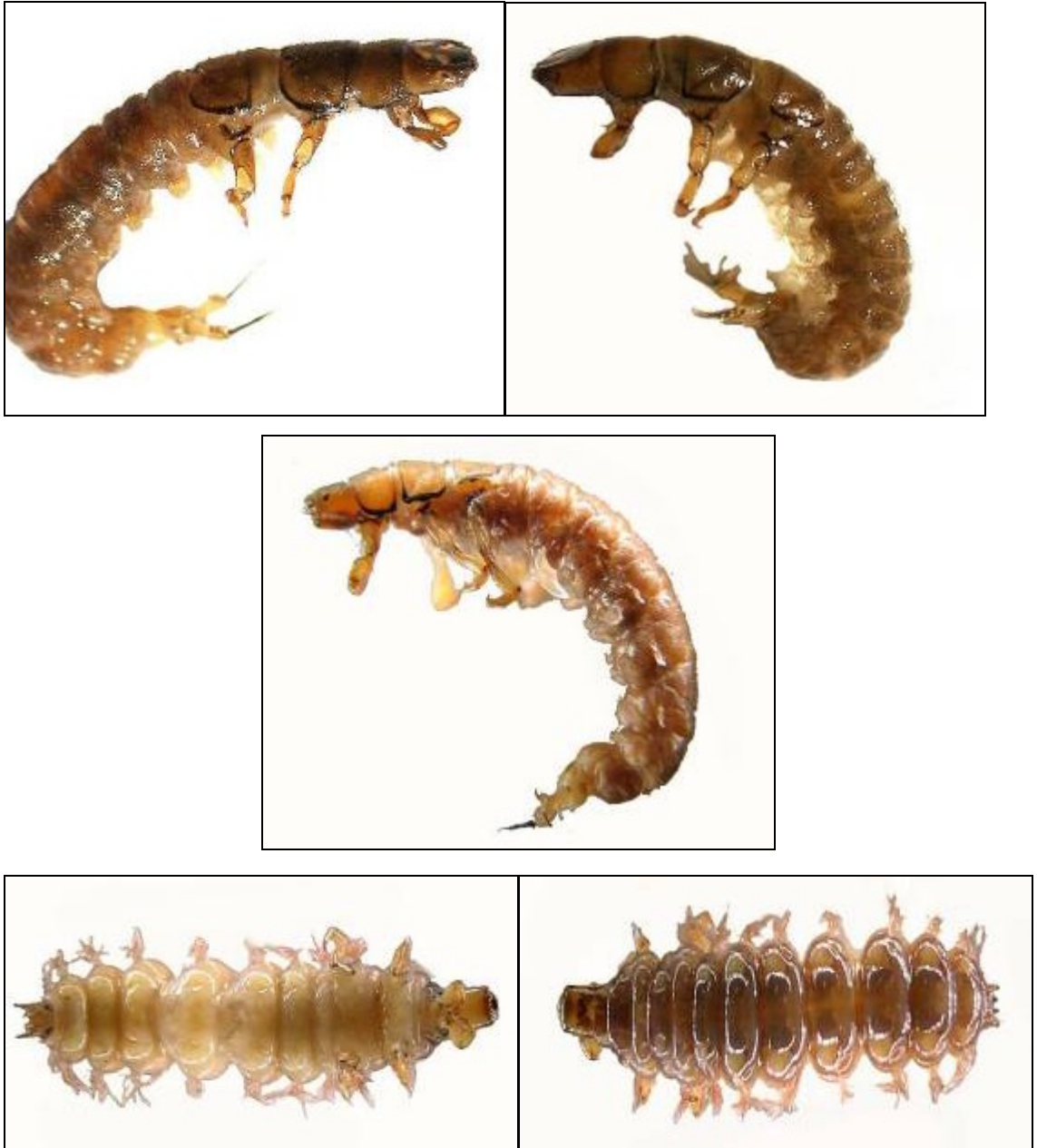


Fig 3.2 B: Larvae with different shapes and colors. From up: Lepidostomatidae 15mm, Lepidostomatidae 14mm, Rhyacophilidae 14mm.

Gills were in different configuration and number from two gill's rows in both sides of body in Rhyacophilidae (Fig3.3A) to tufts of gills in Lepidostomatidae (Fig 3.3B) or highly branched gill in Hydropsychidae (Fig 3.3C).

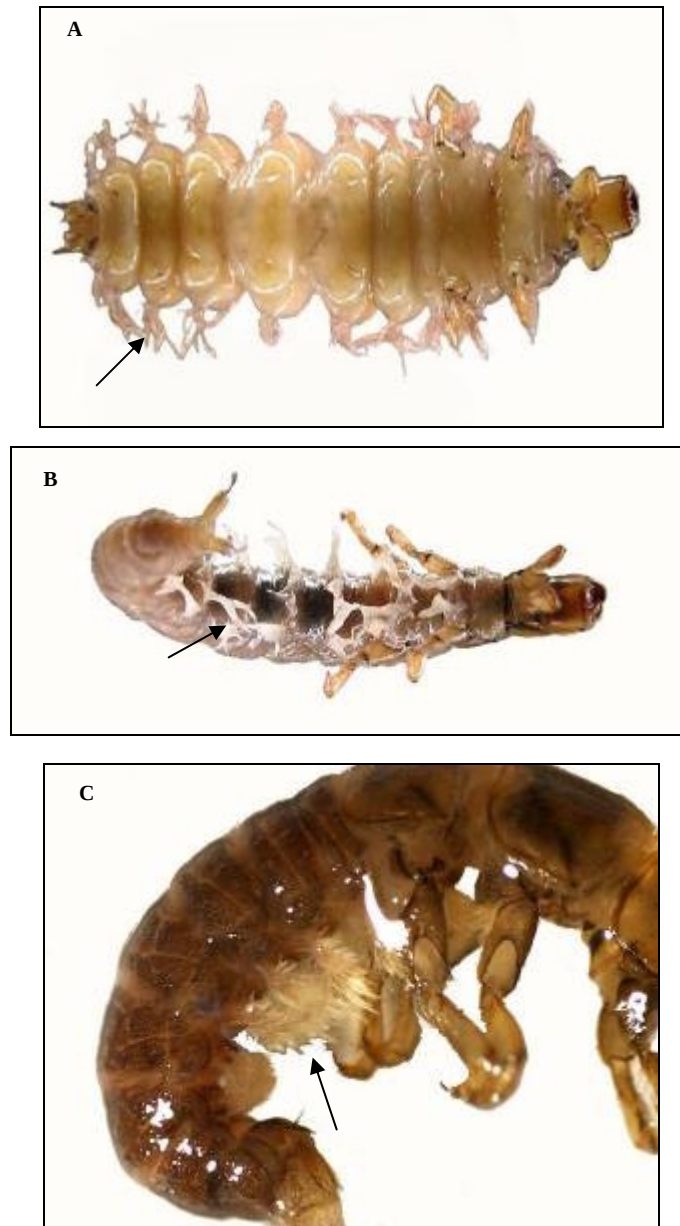


Fig 3.3: Different types of gill in larvae. A: Rhyacophilidae, B: Lepidostomatidae, C: Hydropsychidae.

Variety of anal prolegs, claws and anal setae were seen among larvae. Anal claws had occurred at the tip of prolegs or near it and basal setae were different in length, number and shape from short wide spread to long united hairs.

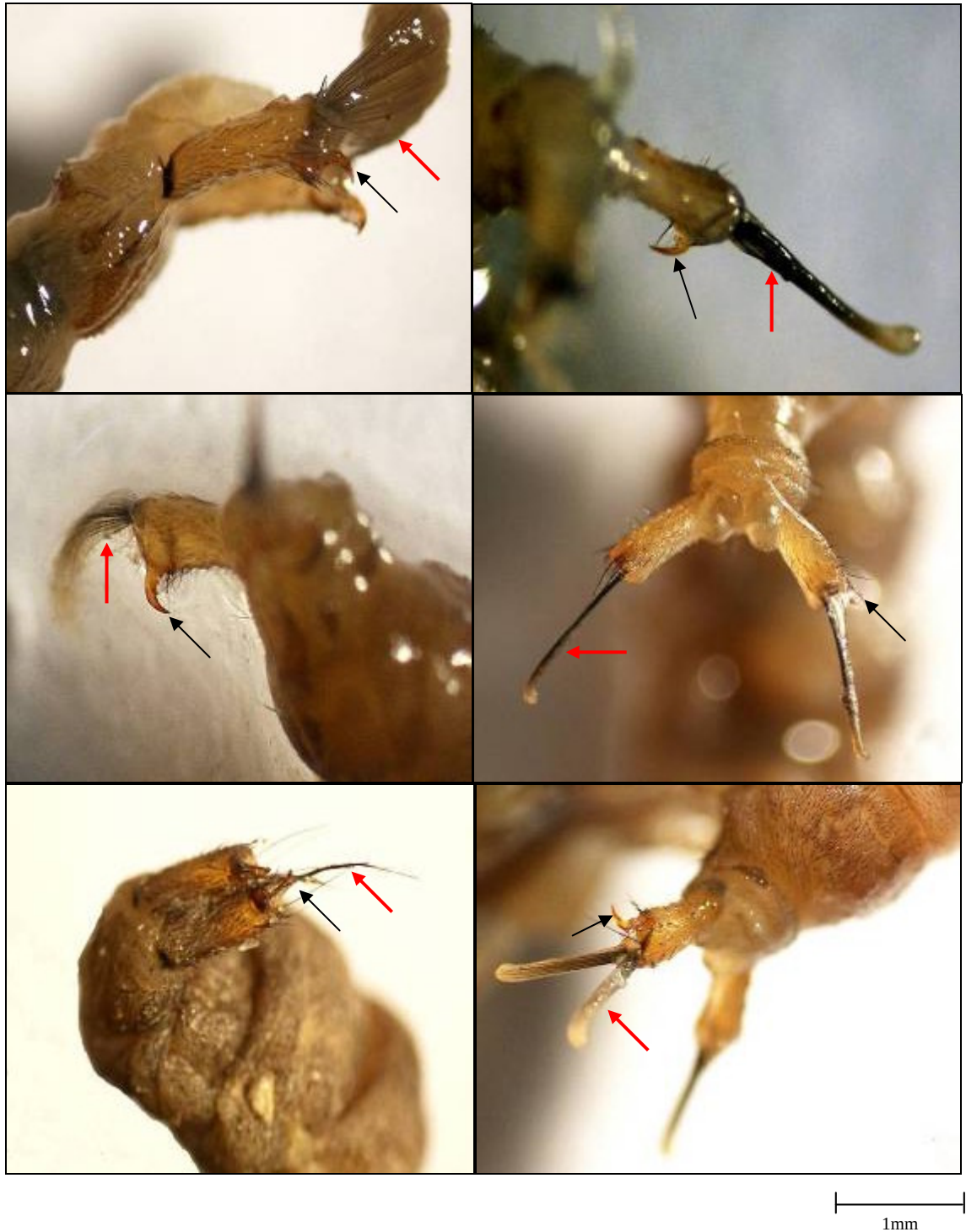


Fig 3.4: Larval anal prolegs with claws (black arrows) and basal setae (red arrows).

The cases had various shape, size and texture. But as a whole two main groups of materials were used in building of cases. Woody cases madding from wood particles, plant debris, dried leaves, etc. (Fig 3.5A) and stony cases composed of pebbles (Fig 3.5B). They were tightly attached to the underneath of water soaked rocks.

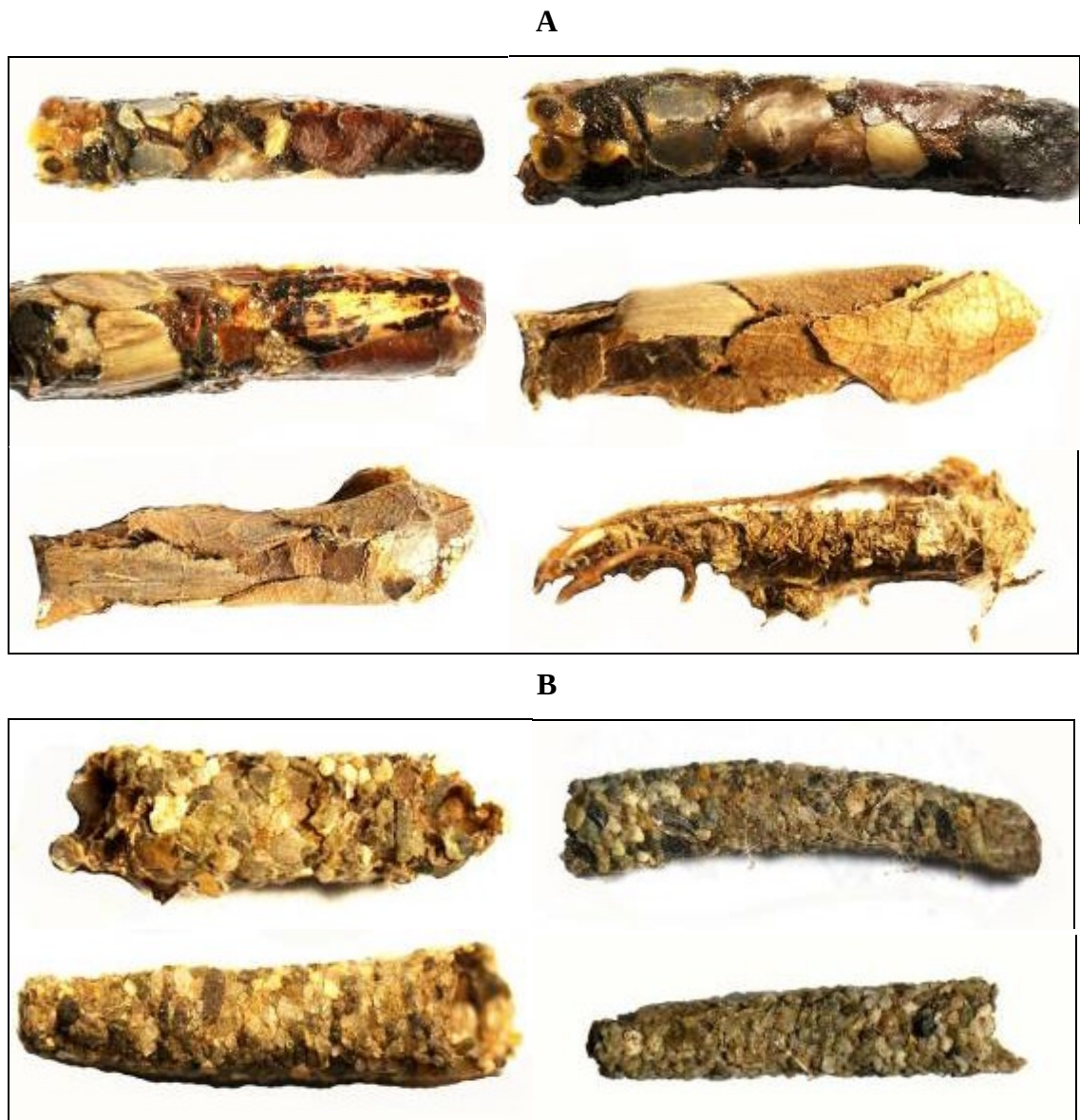


Fig 3.5: Larval cases composed of wooden pieces in about 20- 25 mm length (A) or pebbles in about 5-10 mm length (B).

3.2: Behaviour

During the middle of days, when the water was getting warmer, the larvae used to come out to hunt and feed. They would get back to their cases at the sun set.

Several larvae in collecting sites became stimulated with a piece of wood to see their reaction. Upon feeling danger or stimulating by external objects, the Larvae were rushing backwards into their cases promptly and hide their heads there.

Few larvae from different families were collected and put in a bottle filled with river water to study competition behavior. Some quarrels happened between members of one family not among different groups.

In both stations and also other parts of river, the aggregation of larvae was more in the shade of the trees. Just Few larvae were seen in the vicinity of restaurants and they were completely vanished in urban places.

Six live Larvae were taken to investigate the way they are making cases. The Larvae were fed with smashed vegetables like Cabbage, parsley, celery and leek. 5 out of them died within next 3 or 4 days and only one small larva could remain alive for 7 days. All of the larvae were positioning under the surface chopped vegetables and were scratching their food ultimately ending in a bright thin layer of epidermis. Afterwards, they were trying to stick these slimmed pieces together.

3-3: Pupa

The Pupae appeared from the beginning of May. And at the same time the Pupae as well as the Larvae were present simultaneously. But at the beginning of June there remained no Larvae at all and the cases beneath the stones were full of the Pupae. Pupae were covered in a silky layer (Fig 3.9) within the stony cases (Fig 3.7, 8). Their protective cases were made of small stones attached to the underneath of river-bed rocks (3.6). The used pebbles were significantly bigger than those of larvae. All of the cases were composed of stones even if they had woody cases during their larval stage. The cocoons were arranged side by side as a group or in isolated form.



Fig 3.6: Pupal cases on rocks.



Fig 3.7: Pupa in a home composed of stone pieces.



Fig 3.8: pupa is exited from home (Left: dorsal view, Right: ventral view).

Collected pupae were in different maturation stages. The immature pupae had appearances similar to larvae (Fig 3.9A) that would change to adult in further stages (Fig 3.9B). In some cases remained larval gills would be seen (Fig 3.9C).

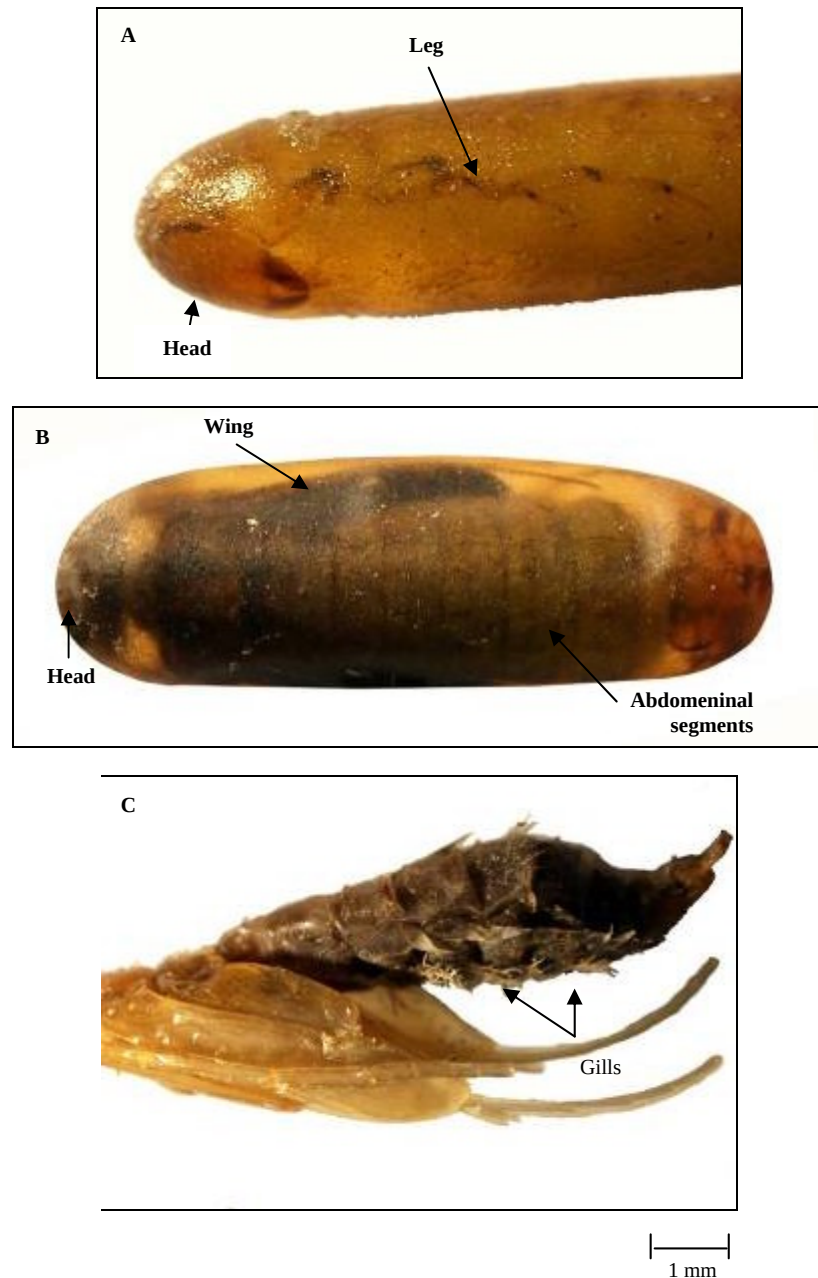


Fig 3.9: Immature pupa (A), adultlike pupa (B), remained gills in mature pupa (C).

Pupae showed variety of shapes and colors (Fig 3.10). Their sizes ranged in 10-15mm. The color was in white, cream and green spectrum. All of the pupae had very long antenna even in some case it was coiled around the tail. Wings and legs were loosely attached to body.

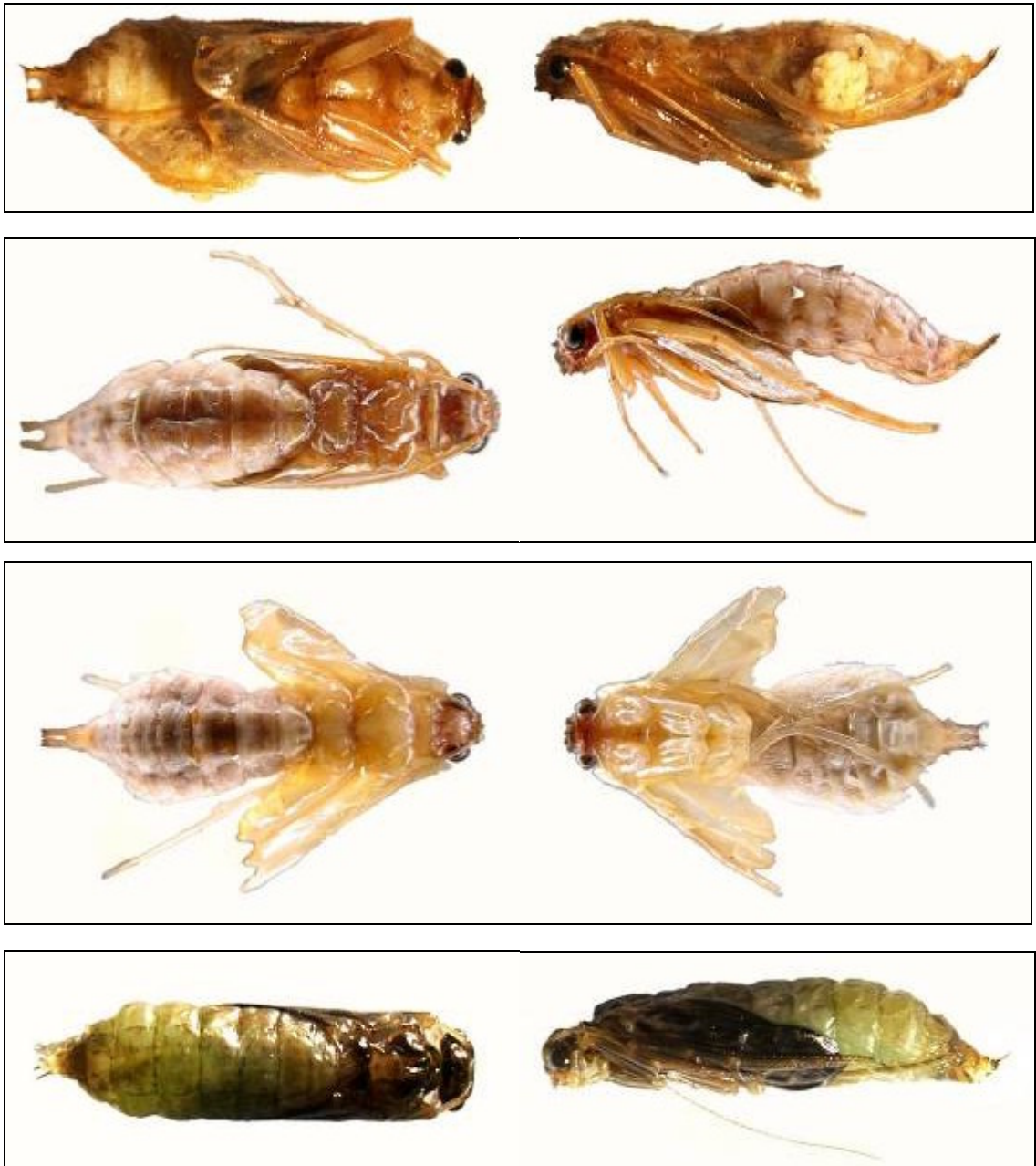


Fig 3.10: Different types of pupae (10- 15mm).

3-3: Adult

I collected 90 adults for this research. The adult stage started at the second half of May with appearing of adult *Philopotamidae D. Ornata* (Fig 3.18, 19, 20) and *Polycentropodidae P.* (Fig 3.24, 25, 26). The abundance and diversities of adults occurred in June and their vanishing happened by the end of July.

The adults were on the wet rocks or waterside vegetations in cool shadowy places. No adults were found far from water.

Their appearance, size and color differed according to family type. They were cream, golden, brown and black with variety of colored patches on wing (Fig 3.11A). The sizes were between 4-11mm and whole body and wings were covered by hair (Fig 3.11B).

A



B

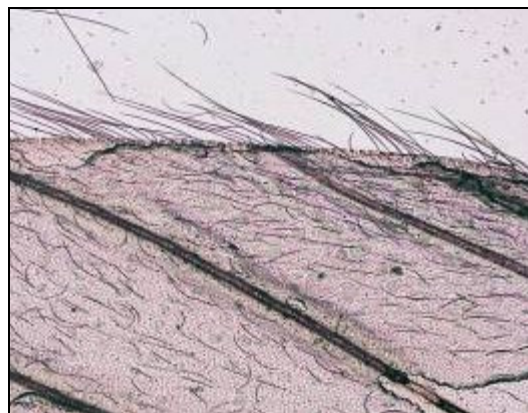


Fig 3.11: Adult in rest (A). Thick hairs on Caddisfly wing (*Polycentropodidae H.*) (B).

Adults pertained to seven families, 7 genera and 7 species (Table 2, 3). According to analyzing of male genitalia and wing venation, the determined samples were: *Lepidostomatidae*: *Dinarthrum chaldyrense* (Fig 3.12, 13, 14) *Hydrobiosidae*: *Apsilochorema iranicus* (Fig 3.15,16,17), *Philopotamidae*: *Dolophilodes ornate* (Fig 3. 18, 19, 20), *Rhyacophilidae*: *Rhyacophila obscura* (Fig 3.21, 22, 23), *Polycentropodidae*: *Polycentropus* (Fig 3.24, 25, 26), *Polycentropodidae*: *Holocentropus* (Fig 3.27, 28, 29), *Hydropsychidae*.

Two species belonged to *Polycentropus* and *Holocentropus* genera had not been described before. Both were discovered through this study. Other species were reported by scientists listed in table 2.

Table 2: Taxonomy of determined specimens with their reporters.

No.	Family	Genus	Species	Reported by
1	Lepidostomatidae	Dinarthrum	<i>chaldyrense</i>	Martynov, 1909
2	<i>Hydrobiosidae</i>	<i>Apsilochorema</i>	<i>iranicus</i>	Schmid, 1959
3	<i>Philopotamidae</i>	<i>Dolophilodes</i>	<i>Ornate(Ornatus)</i>	Ulmer, 1909
4	<i>Rhyacophilidae</i>	<i>Rhyacophila</i>	<i>obscura</i>	Martynov, 1927
5	<i>Polycentropodidae</i>	<i>Polycentropus</i>	New	—
6	<i>Polycentropodidae</i>	<i>Holocentropus</i>	New	—
7	<i>Hydropsychidae</i>	—	—	—

3-3-1: *Lepidostomatidae D. chaldyrense*

Nineteen males and 7 females were collected. In general, body length is 4.5 – 6mm; antennal length was between 4 – 8.5mm; forewing length was between 5.5 - 8mm and hindwing length ranged between 4.5 – 7mm. Number of tibia spurs was 2, 4, 4, and ocelli were absent (Table 3). Thick vein on forewing were used as its taxonomic key (Fig 3.14).

Wing venation (Fig 3. 12) and genitalia (Fig 3. 13) are shown below.



Fig 3.12: forewing (Up) length 6.3 mm, hind wing (Down) length 5.1 mm.



Fig 3.13: Male genitalia.

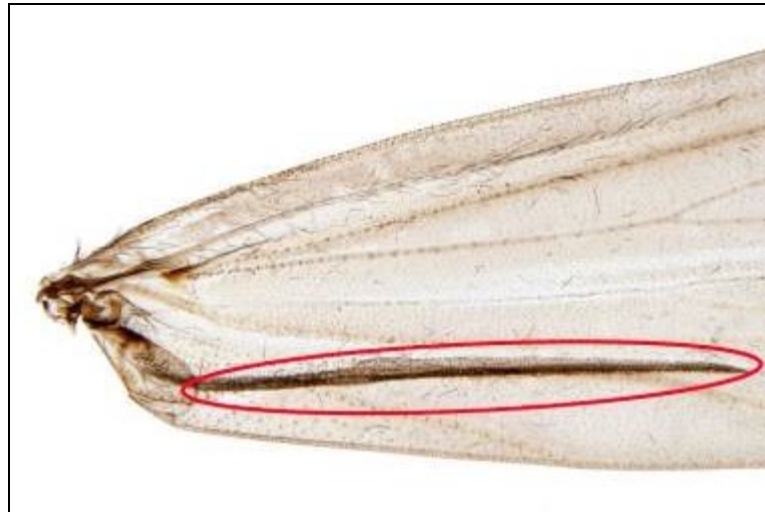


Fig 3.14: Thick vein on forewing (red circle).

3-3-2: *Hydrobiosidae A. iranicus*

Ten males and 5 females were collected. Body length was between 5.5 - 7.5mm; antennal length was between 4.5 - 8mm; forewing length was between 7.5 - 10mm and hindwing length ranged between 6 - 8mm. Number of tibia spurs was 3, 4, 4, and ocelli were present (Table 3).

Wings (Fig 3.15) and male genitalia (Fig 3.16) are shown below. Taxonomic key of wing are shown in fig 3.17.



Fig 3.15: Forewing (Up) length 8.5 mm, hind wing (Down) length 6.6 mm.



Fig 3.16: Male genitalia.



Fig 3.17: Stretched DC (red circle).

3-3-3: *Philopotamidae D. ornate*

Fifteen males and 1 female were collected. Body length was between 4 - 7mm; antennal length between 5 - 8mm; forewing length between 6 - 9mm and hindwing length between 5.5 - 8mm. Number of tibia spurs was 2, 4, 4, and ocelli were present (Table 3).

Wings (Fig 3.18), male genitalia (Fig 3.19) and taxonomic keys of wing (Fig 3.20) are shown below.



Fig 3.18: Forewing (Up) length 7.1 mm, hind wing (Down) length 6.2 mm.



Fig 3.19: Male genitalia.

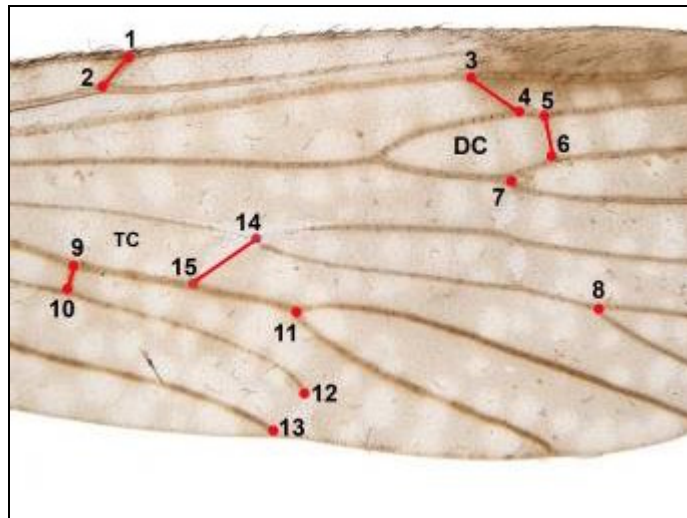


Fig 3.20 : Forewing; DC and TC are present, cross veins C/Sc(1;2) – r(3;4) – s(5;6) – 9;10 and m-cu(14; 15) can be seen, tips of forks I(7) and IV(8) and V(11) are present. Cu2 (12) do not reach the margin but 1A (13) reach it.

3-3-4: *Rhyacophilidae R. obscura*

Nine males and 3 females were collected. In general, body length ranged between 5.5 - 8.5mm; antennal length between 5.5 - 8.5mm; forewing length between 8.5 - 10.5mm and hindwing length between 5.5 - 8mm. Number of tibia spurs was 3, 4, 4, and ocelli were present (Table 3).

Wings (Fig 3.21), male genitalia (Fig 3.22) and taxonomic keys on wing (Fig 3.23) are shown below.



Fig 3.21: Forewing (Up) length 9.4 mm, hind wing (Down) length 6.4 mm.



Fig 3.22: Male Genitalia.

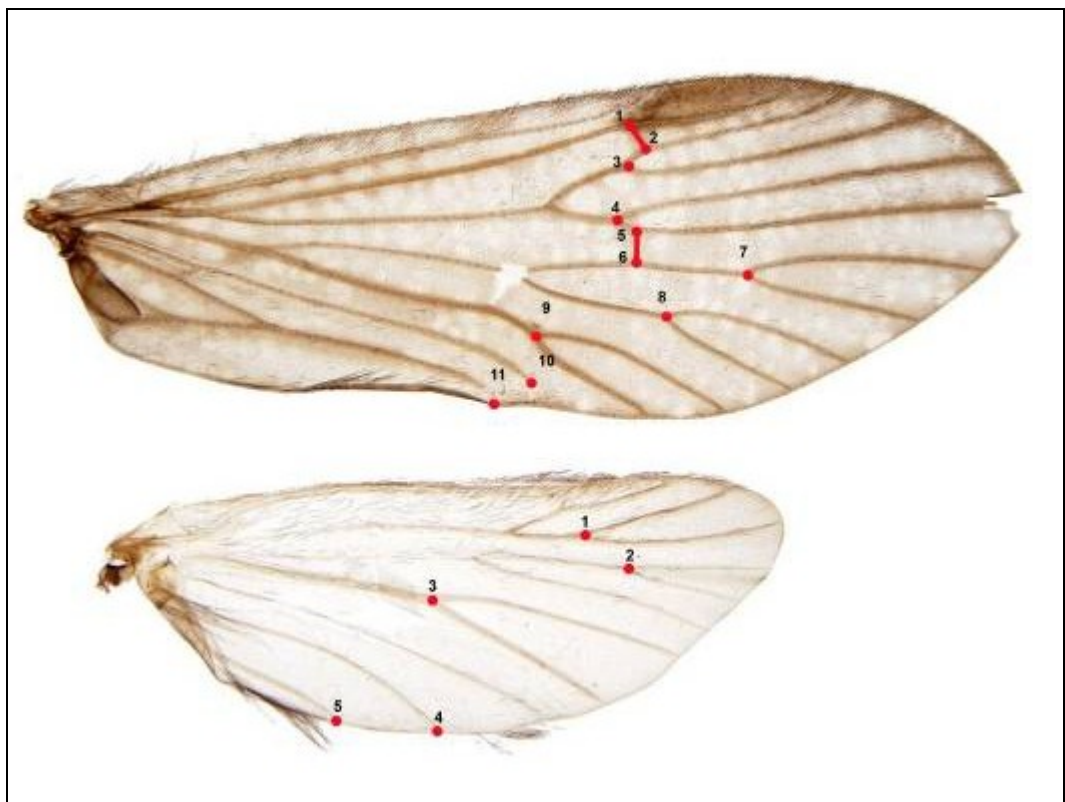


Fig 3.23: Forewing; DC is absent, all forks are present I:1, II: 4,III: 7, IV:8, V:9, two cross veins of r (1;2) and r-m (5;5) can be seen, Cu2 (10) do not but 1A (11) reach the wing margin. Hindwing; 1, 2 and 3 show the tips of forks I, III and V, and 1A (4) and 2A (5) reach the margin of wing.

3-3-5: *Polycentropodidae* P. (New species)

Four males and 2 females were collected. Body length was between 7 - 7.5mm; antennal length between 7.5 - 9mm; forewing length between 7 - 10mm and hindwing length between 6.5 - 8mm. Number of tibia spurs was 3, 4, 4, and ocelli were absent (Table 3).

Wings (Fig 3.24), male genitalia (Fig 3.25) and taxonomic keys on wing (Fig 3.26) are shown below.



Fig 3.24: Forewing (Up) length 7.8 mm, hind wing (Down) length 6.2 mm.



Fig 3.25: Male genitalia.

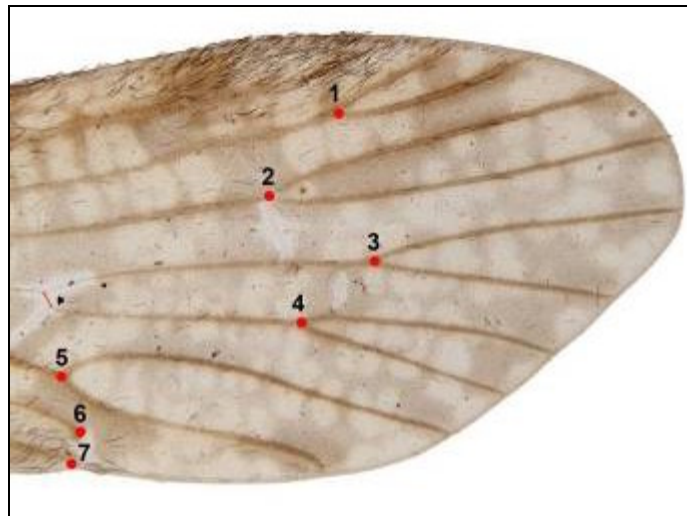


Fig 3.26: Forewing; All forks are present (1, 2, 3, 4, 5 on the tip of forks) but DC is absent. Crossveins r-m and m are present. Cu2 (6) and 1A (7) reach margin of wing.

3-3-6: *Polycentropodidae* H. (New species)

Four males and 6 females were collected. Body length ranged in 5 - 8.5 mm; antennal length was between 8 - 12.5 mm; forewing length between 9 - 12 mm and hindwing length between 6.5 - 10mm. Number of tibia spurs was 3, 4, 4, and ocelli were absent (Table 3).

Wings (Fig 3.27), male genitalia (Fig 3.28) and taxonomic keys on wing (Fig 3.29) are shown below.



Fig 3.27: Forewing (Up) length 11.1 mm, hind wing (Down) length 9.0 mm.



Fig 3.28: Male genitalia.

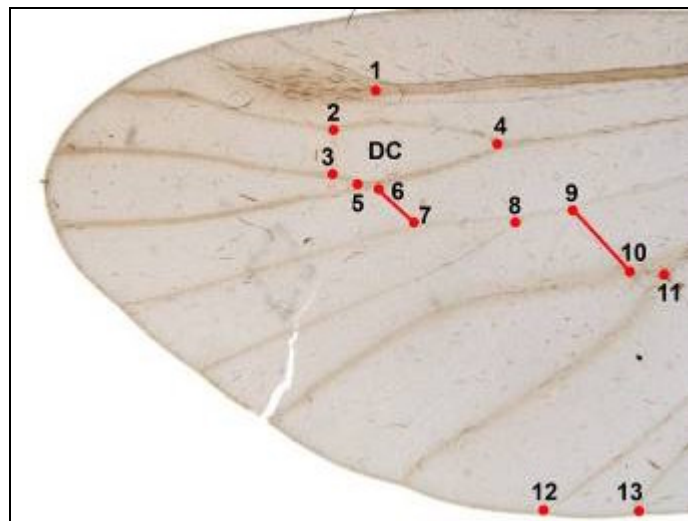


Fig 3.29: Hindwing; DC (2, 3, 4 show the border), crossveins r-m (6; 7) and m-cu (9; 10) and all forks are present (1, 5, 8, 11 on the fork's tip), Cu2 (12) and 1A (13) reach the margin.

3-3-7: *Hydropsychidae*

Five females were collected. No male were collected so the exact taxonomic identification remained incomplete. Body length was between 9 - 11mm; antennal length between 10 - 12mm; forewing length between 9 - 11mm and hindwing length was between 6 -7mm. Number of tibia spurs was 4, 2, 4, and Ocelli were absent (Table 3).

Table 3.2: Statistical information of collected specimens.

No.	Trichoptera	Body L. (mm)	Antennae L. (mm)	Forewing L. (mm)	Hindwing L. (mm)	No. of spurs	Ocelli	Male	Female
1	<i>Lepidostomatidae Dinarthrum chaldyrense</i>	4.5 - 6	5 - 8.5	5.5 - 8	4.5 - 7	2, 4, 4	Absent	19	7
2	<i>Hydrobiosidae Apsilochorema iranicus</i>	5.5 - 7.5	4.5 - 8	7.5 - 10	6 - 8	3, 4, 4	Present	10	5
3	<i>Philopotamidae Dolophilodes ornate</i>	4 - 7	5 - 8	6 - 9	5.5 - 8	2, 4, 4.	Present	15	1
4	<i>Rhyacophilidae Rhyacophila obscura</i>	5.5 - 8.5	5.5 - 8.5	8.5 - 10.5	5.5 - 8	3, 4, 4	Present	9	3
5	<i>Polycentropodidae Polycentropus</i>	7 - 7.5	7.5 - 9	7 - 10	6.5 - 8	3, 4, 4	Absent	4	2
6	<i>Polycentropodidae Holocentropus</i>	5 - 8.5	8 - 12.5	9 - 12	6.5 - 10	3, 4, 4	Absent	4	6
7	<i>Hydropsychidae</i>	9 - 11	10 - 12	9 - 11	7 - 9	4,2,4	Absent	-	5

3-4: Egg

After disappearing of adults at the end of July, egg masses were seen on the wet rocks in river together with some small primitive Larvae which were belonged to the next generation.

Egg masses were in different sizes, shapes and colors. Their sizes were in range of 7-15mm. Masses were mostly unshaped cream and a few were round and green. They had been mostly laid side by side.



Fig 3-30: Egg masses on the wet rocks on waterside (up to down: 7mm, 15mm, 15mm).

Chapter 4

Conclusion

Conclusion

This survey presented types of Caddisflies in Darband River. Similarity of recognized species in both stations similarity of their environment conditions which were the best for rising of Trichopteras. Places with running water, tall trees to shade, waterside vegetations, lower temperature and far from urban life had most population of trichopteras.

The captured larvae couldn't stay alive as they needed their natural habitat such as well oxygenated current water, their common water bed and foods, *etc.*, reveals high larval sensitivity to the habitat they live in. The built cases by these larvae also showed that used material in their cases depends on around particles not type of family.

No Caddisfly had been seen in vicinity of restaurants built alongside of river and it should be in result of water pollution at these parts.

Chapter 5

Discussion

Discussion

This research was done on one generation of Caddisfly in spring and summer with warm weather condition. May be in the next generation in autumn and winter with cool weather, the new species grow.

Different parts of Iran have different climate and environment which might be good places for growing of Caddisfly even new species which are unknown as two determined species in this project.

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