A Contribution to the Life History of *Chimarrha albomaculata* Kolbe from Puerto Rico (Trichoptera, Philopotamidae)

Boyd B. Palmer
University of Illinois

During the months from April to September I was interested in collecting immature stages of Trichoptera in the mountain streams of the southwestern part of Puerto Rico. These streams are tributaries of the Mayaguez, Quanajibo, Flores, Yauco and Arecibo rivers. When the larvae and pupae were reared to the adult stage, the most abundant form proved to be *Chimarrha albomaculata* Kolbe, which was first described by H.J.Kolbe (1888). He based his description primarily on color. In spite of the abundance of this form, there are no redords concerning the immature stages of this colorful species.

The larvae and pupae were most plentifully found in the tributaries just above their confluence with the larger streams and rivers, where the current is relatively moderate in comparison to the swifter upper parts. At the lower altitudes the streams are wider, the stones somewhat more numerous, and often covered with algal growth, the food of the larvae. In the parts of the streams which are 2500 feet above sea level, *Chimarrha albomaculata* practically disappeared, while other forms of Trichoptera became more abundant. Here the current is swift, the bottom solid rock, and there is much less plant life in the streams themselves.

I wish to express my appreciation to Professor C.L.Metcalf for his direction and assistance.

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W.H. Bradley states that the specimen cases of two species of Limnephilidae are very numerous, making conspicuous layers in oolitic limestone formations of the Eocene period. Also a small case in irregularly arranged pacts through at least a foot of rock, built in tiers, which seemed to belong to Sericostomatidae. E.W.Berry says, that there have been about 200 species discribed from the Tertiary period. A large variety of Trichoptera have been described from the Baltic Amber, That the Trichopterous tubes form an indusial limestone in the lower Miocene, which in several places is several feet deep over considerable area in central France.

The insects found in the most important deposits in the United States are given as follows by T.M.Carpenter:

Latah beds of Washington
15% Trichoptera 5 were Limnephilidae I was Phryganeidae

Floressant schales
4% Trichoptera
95% Hydropsychidae
4% Phryganeidae
1% Limnephilidae

It is interesting to notice how widely distributed the Trichoptera were geographicaly during these geological times. The countries from which the fossils forms listed above were taken, are as follows: Bavaria, Bohemia, Denmark, England, France, Greenland, Italy, Isle of Wight, Prussia, Siberia, and the United States. In the United States from Colorada, Tennessee and Wyoming.

In general the geological record of Trichoptera is rather recent but the forms found show that They were well along in their evolutionary development and well distributed over the earth.

Geographical Distribution

As the geological records have already shown we naturally would expect a very wide distribution today. This distribution is best shown by Betten's summary of Ulmer's work, which is as follows:

1. Trichoptera are found in all parts of the earth with the exception of the Hawaiian Islands.
2. With some exceptions (Chimarrha) it is the largest genera such as Hydropsyche, Limnephilus etc., that are the most widely distributed.
3. The number of small genera of restricted distribution is very large.
4. A most striking feature is the entire absence of Phryganeidae and of Limnephilidae (the latter with a few exceptions in Chile) south of the Equator.

Betten also states that what little is known of the Nearctic fauna, shows close relationship to those of Europe and Asia.

The total number of genera reported by Betten are 123 and of species 568 which he distributes as follows:

261 from the U.S. and Canada east of the Mississippi river
271 from the U.S. and Canada west of the Mississippi river and Greenland, Central America, and the West Indies.

Ecological Distribution

The Order as a whole are aquatic and the larvae may be found inhabiting all kind of aguatic situations from lakes and sluggish streams to rapid mountain streams. The different species showing special adaptation for their particular environment. McLachlan records a Marine Caddis fly from New Zealand. One species has been recorded as living in large Bromelid plants . Siltala made a study of Finland Bay and found a total of 61 species livinging in different presentages of salt water varying from .2% to .6%. . Some species inhabit streams that are dry for a part of the year. There is one terrestial species living in moss. The adults being rather weak fliers do not get very far from the bodies of water where they were developed, although they may be carried some distance with the wind as other forms. The adults usually fly where they can quickly get under cover. A large number are night fliers or fly just at dusk.

Economic Importance

The economic importance of Trichoptera may be summed up as follows:

1. Food for fish, ranging from 0% to 75%
2. Pests around summer resorts at time of breeding and hatching.
3. Possible source of Coryza and Asthma.
4. Attacking wood of bridges.
5. Food for Birds.
6. Injurious to fishermens nets.

Discription of the Order

In Westwoods, "Introduction to the Modern Classification of Insects" I840, he gives the following discription of the order: Adult

" Wings four membraneous anterior Piolose with branching nerves, the Posterior larger and folded when at rest. Prothorax very short. Tibia with long calcania at the tip and often beyond the middle of the limb in the four posterior legs. Mouth parts unfited for mastification, mandibles rudimentary.

Larvae hexapod, ordinarily residing in cases formed by various materials, in which it retains its station by means of two hooked anal processes.

Pupa incomplete, inactive during the greater period of its exsistence.".

In comparing this discription with those of to day we find it is very complete and gives the essential characteristics but for more detail I will state the other characteristics in outline form.

Adult

Head

- Small, transverse
- Almost always a number of tubercles
- Compound eyes small
- Ocelli if present always three in number
- Mandibles none functional, may be lacking
- Maxillae reduced to a basal lobe and palp
- Labrum consists of submentum, mentum, and haustellum

A Labium normal

Antennae

- Set between eyes almost touching them
- Usually filiform
- Length varying from little shorter than wings to 3 or 4 times the length of the wings
- Usually hairy more at basal segments
- Second segment of antennae always shorter than others

Thorax

- Prothorax very small
- Mesothorax much larger supporting hairy tegulae
- Meta thorax smaller then mesothorax and less hairy
- Sterna of thorasic segments hid by large coxae

Continuation of out line of characteristics

Abdomen
Spindle shape ,middle segments thickest and longest
Ten segments,first 7 of female and 8 of male mormal rings
Tergites and sternites united by membranous pleura
Nineth segment of male completely chitinized,bristles shape
A varies greatly
Anal appendages arising from dorsal side of the 9th segment
Claspers appandages arising from the ventral side
Penis arising between IOth segment above and claspers below
Cerci present in a few Rhyacophilidae.

Legs
Long and slender
Coxae are large
Trochanter small
Femur and tibia long varying in amount of hair and spurs
Tarsi 5 segmented claws

Wings
Four membranous,two exceptions have been mentioned
Anterior heavier,when at rest form roof like over body
Hind wings folded
Hairiness of wings varies greatly,hind wings sparsely covered
Wings joined during flight by the following ways;
I. Spines on inner margin of underside of hind wing
2. Fusion of Costa and subcosta of hind wing
2. Presence of fibula homologous with jugum
3. Costal margin of hind wing with frenulum
4. Costal margin og hind wing with hooks

Venation
Betten states that since the function of flight is not well exercised that therefore no strong type of venation is well established. The most primitive type is present in the genus Rhyacophila.

Eggs

Two types have been described,one in which the eggs are layed in a gelatinous mass which greatly swells when placed in water. The second type has little cementing material and no swelling when placed in the water. The egg masses may vary from I5 to 800 in different species.

Larvae	Campodia form	Eruciform
	Long axis of the head continuous with thar of the body	Long axis at right angles with that of the body
	Mouth directed cephalad	Mouth directed ventrad
	Body depressed	Body cylindrical
	Legs long and equal	Front legs much shorter
	Abdominal segments sharply constricted	Abd.Seg. not constricted
	Prolegs long ,slender and movable	Prolegs short,thick and fixed
	Lateral lines wanting	Lateral lines present
	Prosternal horn wanting	Prosternal horn present
	Abdominal tubercles wanting	Abd.tubercles ususlly present
	Rectal gills usually present	Rectal gills wanting,Exc.Leptocerid
	Free living,net builders except in Hydroptilidae	Build portable cases.

Continuation of outline of characteristics

Larvae Cases

The most complete work on Trichopterous cases that I found was that of G.S.Dodds and Fred L.Hisaw in Ecology VI No2 April I925.pI23-I37. In this article he they divide the cases in to the eleven following types:

I. Fragments of plants material,arranged lengthwise in crude and irregular manner of different sizes.Materials used were sedge stems,leaves of pine and spruce and twigs Found in quiet waters. These cases belonging to 6 species of Limnephilidae.

2. Fragments of plant material arranged cross wise making a shaggy case often as broad as long.Same materials as used in cases above. Found only in ponds with good plant growth and much debri on the bottom. Also cases of Limnephilidae.

3. Similar to preceeding case but pieces of material are arranged oblique overlapping but not smoothly. Live in Lakes and quiet margin of streams. Also cases of Limnephilidae.

4. The cases are straight cylinders,but built of thin pieces of leaves,cut to uniform length and arranged spirally making a thin,neat case as if built of spirally wound ribbon. Found in ponds and lakes with much silt and plant growth. Belonging to Glypholaelins of Phryganeidae.

5. Case is built of fine grains of sand,slender,slightly tapered, and a little curved to which are attached longpieces ofspruce needles or decaying wood. They are found along shallow shores of ponds among sedge stems. They belong to Mystacides canadensis of the family Leptoceridae.

6. Cases built rather fragilely of fine grains of sand,of about uniform size.Some what compressed dorso ventrally. It is characterized by expansion at the sides into broad lamellae. The dorsal wall forms a hood.Found on sandyshores of lakes and slow streams. Belonging to Molannidae.

77 Large cases built of good size sand grains .A slightly curved cylinder of about uniform diameter.Found on surface of rocks, in moderately swift streams,occasionally found on the shores of clean bottom lakes at high altitudes.Belonging to Limnephilidae

8. Cases built of fine fibers wound around insuch a way to form a square cross section,except in old specimens where it has become rounded by internal pressure.Smaller at the posterior end. found in swift streams of good volume,headed up stream and cemented to rocks where water flows overthem. Belonging to Sericostomatidae.

99 Case of general cylindrical form,but tapering toward the
9 posterior end and slightly arched,with concavity ventrad. Materials small particales of sand or rock fragments.

Sub-types;

a. Case built of large angular sand grains making rough cases.Posterior end slightly smaller.Found in quiet parts of swift streams and certain lakes of high altitude.

b. Shaped as case above but materials are of mica,small grains of sand and bits of wood. A thin case. Found in sedge zone of swift streams where current is flowing about 2 to 3 feet per second and in high altitude lakes. Belonging to Hesperophylax designates of Limnophilidae. It builds a different case for the pupa stage?

Leptoceridae

Inhabit lakes, ponds dilations of streams, except in Leptocerus which is found inriffles of streams and on stones of well beaten lake shores.

Food of vegetable origin.

Seme larvae are rapid swimmers.

Eggs are layed in gelatine masses on vegetation above the water or under the surface of floating leaves. The egg mass of Leptoceridae differs fromother Trichoptera in having an outer membrane of a darker color. The egg mass of Triaenodes is pecular in forming a string coiled like a watch spring. Material of case also arranged in a spiral fashion.

Adults emerge in June and July.

Phryganeidae

[illegible].

They are primarily bottom dewellers, seldom climbing into vegetation.

Found incool, slowly moving streams. Prefer shaded places.

Some abandon their cases and build larger ones.

Food consists of dead and living plant material.

Eggs are passes in a round gelatinous cord which is then fastened to some support, in the form of a complete circle.

For pupation they seek root masses or soaked roots and logs.

Emerge in early spring.

Both night and day fliers.

Limnephilidae

Fitted for life in almost every aquatic situation. More numerous then all other Trichoptera put together in ponds and slow moving streams that dry up during the summer. In streams where the water becomes swifter the number become less. The gill surface decreases as they inhabit more rapid streams. It is in this group that the only terrestial larvae are found.

Food consists of vascular plants, living or dead, and also daitoms.

Use most every kind of material in building cases.

Larvae crawl over bottom or on subermeged plants. They are a important food for muskrats.

Newly hatched larvae are heliotropic.

Pupal cases are not attached to stones but lie on the bottom beneath rocks.

Eggs are layed out of water, placed on leaves or stems.

Sericostomatidae

Larvae found on bed of stoney streams and lakes in sand and gravel.

They crawl over current swept rocks.

One species Brachycentrus nigrisoma has its case built five hours after hatching. First two weeks its food consists of diatoms, the third week algae and bits of seed plants, the sixth week it had become carnivorous.

Phylogenetic Position of Trichoptera

The phylogenetic position of Trichoptera has been a point of argument for some time between various workers. There has been from the first a desire to place them with the Neuropteroid group. Later others felt that they were closely related to the Panorpidae. Still others bring out a close affinity with Lepidoptera, which would indicate that they probably all came from closely related forms.

Packard believed the Trichoptera were more closely related to the Panorpidae on the basis of similarity in the structure of the sclerites of the head and thorax. Others based this relationship on structure of the genitalia and wings.

Crampton points out the following similarities between the Micropterygidae and Tricoptera as follows:

Mnemonica and Philopatamus

1. Head capsules similar in general outline.
2. Lateral region of thorax very similar.
3. Divisions of mesothorax very similar.
4. Scent glands at base of hairs .
5. Wing coupling apparatus.
6. Larvae of both live in and on moss and algae.

But he also felt that Comstock should not remove the Micropterygidae from the Lepidoptera and gives the following reasons to support his position.

1. In the larvae gonopods are present only in Trichopterous forms.
2. In the adult of theTrichoptera the gonostyle always cocsists of two segments, while in Lepidoptera of one.
3. Pupa of Trichoptera do not have distinct spiracles.
4. Scales of the two are different.
5. Absence of medial ocelli in all Lepidoptera.
6. The subdivision of the mesothoraxic coxa for its entire length into euocoxa and merocoxa in all Lepidoptera and only partial division in all Trichoptera.

Braun brings out in his article "Wing Structure of Lepidoptera", that certain characters such as, modes of holding wings together, and fixed hairs on the wings are persistant primitive characters that should indicate their close relationship.

Crampton gives the following diagram which gives some idea of the more general accepted view of the r elationship of the orders in guestion.

Phylogenetic Relation of Families of Trichoptera

The keys of classification available now for Trichoptera give us I3 families which can be divided in a general way into primitive and specialized groups. It might be well to consider first what the workers in Trichopter would call primitive characteristics. Betten has summed up the primitive characteristics of the Order as follows:

Eggs
- Primitive type - When eggs are layed individually against a substratum with little gelatinous material.
- Specialized - When eggs are layed in a mass and has an abundance of gelatinous material.

Larvae
- Primitive type - Thysanuriform, net builders, arrangement of appendages alike in all larvae of first stage.
- Specialized - Eruciform, case bearing, arrangement of appendages in later stage replaced by a secondary armature.

Pupae
- Primitive type - Pupa in complete cocoon and is not active, no apparatus for cleaning case membranes.
- Specialized - Pupa in incomplete cocoon and active. Apparatus for cleaning cases.

Adults
- Primitive type - Mandibles rudimentary, palpi 5 segmented Wings absence of intercubital cross veins.
- Specialized - Haustellum, palpi less then 5 segments. Wings with intercubital cross veins.

It might seem that with a group of characters as listed above one would be able to separate them very readily but this is not the case for one family may show primitive characters of one kind and specialized characters of another and so would have different combinations.

Hagen would place Hydrosychidae first followed by Rhyacophilidae based on geological evidence. Muller places them in the same way because of the careless habits of larvae and condition of male palpi and venation. Klapalek places Rhyacophilidae first on basis of the genitalia. Betten places Rhyacophilidae first followed by Philopotamus. He claims that the specialization of the palpi in Philopotamus is in the direction of the Hydropsychidae and is not present in Rhyacophilidae.

On the basis of number of segments in the palpi we find them first divided by Kalenati I848, which was also adopted by Ulmer? The more generalized forms coming under the name of Aequipalpia in which both sex have 5 segments.

Adult. --- Body 4 to 5 mm. long. Wing expanse I4 to I5 mm. The color of the following parts is golden brown; the head, antennae, first and second segments of the maxillary palpi, the labial palpi, thorax, prothoracic leg as far as last tarsal segment, meso- and metathoracic legs except tarsus. The other segments of the above appendages and the tibial spurs are a dark brown. The abdominal tergites are lighter in color on the caudal margin, elsewhere brown. The sternites are a lighter brown. The fore wing (Plate I, fig. 1) has seven silver hairy spots, the rest of the wing being covered with black hairs. The hind wing is somewhat lighter and less hairy. The apical margins of both wings are fringed with white hairs, while the caudal margins of both wings are fringed with brown hairs. In the venation (Plate I, fig. 5) Sc is unbranched. M_4 is lacking in both fore and hind wings. There is one inner short spine on the fore tibia, 4 spines on the meso- and metatibiae. For the genitalia of the male and female see Plate I, figs. I, 3, and 4. The genitalia of the female were drawn from a mature pupae.

Pupa, --- Male 7 mm. long, 1.5 mm. wide. Female 9 mm. long, 2 mm. wide. The changes in the pupal development are chiefly of color and compactness of body. The newly formed pupa is a light yellow with the exception of the fringe of brown hairs on the outer margin of the tarsus of the mesothoracic legs, while on the inner margin the fringe is white. The colors gradually change to those given for the adult. The mandibles are conspicuously long, flat, and thin, with well developed serrate teeth (Plate II, fig. 8). The arrangement of setae on the head is as shown in Plate II, fig. 7 and on the rest of the body as in Plate II, figs. I0, I2, and I3. The hind legs usually reach to the end of the abdomen. The antennae extend to the 5th sternite at least.