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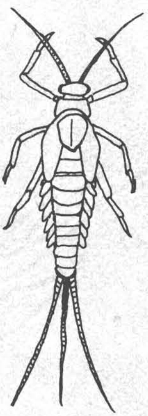
Limnological Studies of Four Different Neotropical Ecosystems with Special Reference to their Ephemeroptera Fauna



Dissertation from the Department of Zoology and Limnology – GHS Kassel, Universität des Landes Hessen

Lewis Berner

Limnological Studies of Four Different Neotropical Ecosystems with Special Reference to their Ephemeroptera Fauna

Dissertation
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LIST OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Limnological studies related to running waters in Tropical America are scarce and incomplete. A good part of this work deals with the Peruvian Andes and different parts of the Amazonian region, but most of the Neotropics remains untouched in this field of study.
ILLIES (1961) makes a comparative limnological study between Europa and South America, and the same author (1964) discusses the results of the invertebrate fauna collected in Rio Huallaga,Peru. PATRICK (1964) reports in a general way the results of the Catherwood Expedition to the Peruvian head waters of the Amazon; the biota is reported only at Phylum and Class level. EGLER & SCHWASSMANN (1964) discuss the importance of changes of water level of the Amazon estuary and some physical parameters related to it. FITTKAU (1964) gives information about the biota in the Central-Amazon rain forest streams; Potamanthidae, Leptophlebiidae, Baetidae, and Caenidae are the mayfly fauna represented in this area. KLINGE & OHLE (1964) discuss some relationships between land and water in the Amazonian landscape. SIOLOI (1964) pointed out some physical and chemical characteristics of Amazonian rivers. ILLIES (1969) discusses the biogeogrphy and ecology of neotropical freshwater insects, especially those of running waters. From the ecological point of view, this is the most comprehensive study found in the present investigation.
ALLEN & BRUSCA (1970) present the geographical distribution of some genera of Ephemeroptera in North, Central, and South America, but no ecological data are discussed.
In Colombia this field of ecological research is almost nonexistant. ROLDAN et.al.(1973) and PEREZ & ROLDAN (1978) give information about the macroinvertebrate fauna in the Me-

dellin and Rio Rionegro rivers and the effects on their community structure, due to the industrial and domestic pollution. Beyond these publications no more studies are available for Colombia in this field.

From the taxonomical point of view there are several studies about neotropical Ephemeroptera, but most of them are still incomplete and scatered in different publications. The following are the most important publications known up to now.

WEYENBERG (1883) presents and discusses some aspects of the known South American Ephemeroptera. EATON (1883-1888) presents one of the first comprehensive studies about neotropical Ephemeroptera, including some Colombian species. ULMER (1921,1942,1943) describes and discusses some of the mayflies from Central and South America. NEEDHAM & MURPHY (1924) present the first comprehensive study about Neotropical mayfly fauna. TRAVER (1944) gives a key to the families and genera of South American mayflies based mainly on the Brazilian mayfly fauna. DEMOULIN (1955) gives a report of the Ephemeroptera collected during the Belgian Bilogical Mission in South Brazil and Amazonan region. ROBACK (1966) presents a report of the Ephemeroptera nymphs collected during the Catherwood Foundation Peruvian-Amazon Expedition.In this report, 25 genera and 57 unnamed species are included. PACKER (1966) reports the results of a preliminary study of mayflies from Honduras.

Many more contributions have been made in the past 20 yeras about the Central and South American mayflies. Some of the most important studies that must be considered by research workers in this field are the following:

ALLEN,1967,1973,1977; ALLEN & BRUSCA,1970,1973,1978; ALLEN & COHEN,1977; ALLEN & ROBACK,1968; EDMUNDS,1966,1972; MAYO, 1968,1969,1972,1973; TRAVER,1960,1971; TRAVER & EDMUNDS,1967, 1968.

Recently EDMUNDS et.al.(1976) published a book dealing with the mayflies of North and Central America. The value of this publication is that much of the information given about the Central American genera could, in theory, be applied to other neotropical regions with similar ecological conditions. With this in mind, the key presented by this authors was adopted with some modifications for the present study, and was considered satisfactory in most cases.
Because of the virtual lack of information about the mayfly fauna in Colombia, the present study must be considered to be of a pioneering nature. But even with this limitation, this thesis intends to provide basic information for future research work in this country.
The following are the main objectives in the present study:
1) To contribute to the knowledge of the Neotropical Limnology which still is very poor, particulary in Colombia.
2) To show how mayfly aquatic communities in tropical rivers are constituted.
3) To show how the physical and chemical factors change with time, due to the rainy and dry seasons.
4) To establish the effects of pollution on the invertebrate community struture using the mayfly fauna as indicator of water quality, since these organisms are particulary sensible to water pollution.
5) To set the basis for future ecological and taxonomical studies of the mayfly fauna in Colombia.

DESCRIPTION OF THE STUDY AREA

Four different sampling stations were selected for this study: Rio Anori (Providencia), Rio Medellin (Primavera), Rio Rionegro (El Tablazo), and Quebrada La Agudelo (El Retiro), all of them located in the Departamento de Antioquia, Colobia(Fig.1). The following are the ecological characteristics of each area.

Rio Anori (Providencia)

Located in Providencia area, 200 km North East of Medellin, at 7^{o} 30' North and 75^{o} 04' Weat (Fig.2).
This place is located at 540 m above sea level. According to the HOLDRIDGE life zone classification (ESPINAL,1964) this zone corresponds to a transition between a tropical rain forest (bh/bmh-T).This ecological life zone is characterized by having a mean air temperature of 26.0 ^{o}C through the year and a mean precipitation of 4500 mm (Fig.3A). The forest in this region is still well preserved and protected. For this reason the water level of the river is kept controled and remains clear through the year. There are no pollution sources in the area. The river has a rocky bottom and fast current.

Rio Medellin (Primavera)

Located in the Primavera area, near Caldas Town, 24 km south Medellin, at 6^{o} 10' North and 75^{o} 65' West (Fig.2).
This station is located at 1550 m above sea level and corresponds to a premountain heavy rain forest (bmh/PM), with a mean air temperature of 20.0 ^{o}C through the year and 3500 mm of precipitation (Fig.3B). The forest has been completely cut down, and besides erosion, the river is affected by agricultural activities in the area and moderate local pollution sources. The river is also affected by sand extraction. For this reason the river remanis silty most of

the year. It has a rocky bottom and a medium speed current.

Rio Rionegro (El Tablazo)

This station is located in the Pantanillo area 30 km south East of Medellin, at 6° 14' North and 75° 40' West (Fig.2).

The station is located 1900 m above the sea level, and corresponds to a lower mountain rain forest (bh-MB) with a mean air temperature of 16.0 °C and a mean precipitation of 1200 mm (Fig.3C). The forest has been completely cut down and the land is used for agriculture and raising of cattle. The river is affected by erosion and moderate organic pollution from farm houses. The bottom consists of pebbles and sand which make it silty for a great part of the year. The current is slow.

Quebrada La Agudelo (El Retiro)

Located near to El Retiro town, 32 km South East Medellin, 6° 03' North and 75°52' West (Fig.2).
This station is located in a lower mountain rain forest (bmh-MB) at 2000 m above sea level, with a mean temperature of 15.0 °C and a mean precipitation of 3000 mm (Fig. 3D). This brook is located in an area in which the forest has been replaced by a pine plantation and is free of erosion for most of the year. The water is also unpolluted and of slow current. This was the smallest ecosystem studied.

Fig. 1. Tropical America or Neotropics include the countries comprised between Tropic of Cancer in North and Tropic of Capricornic in South.

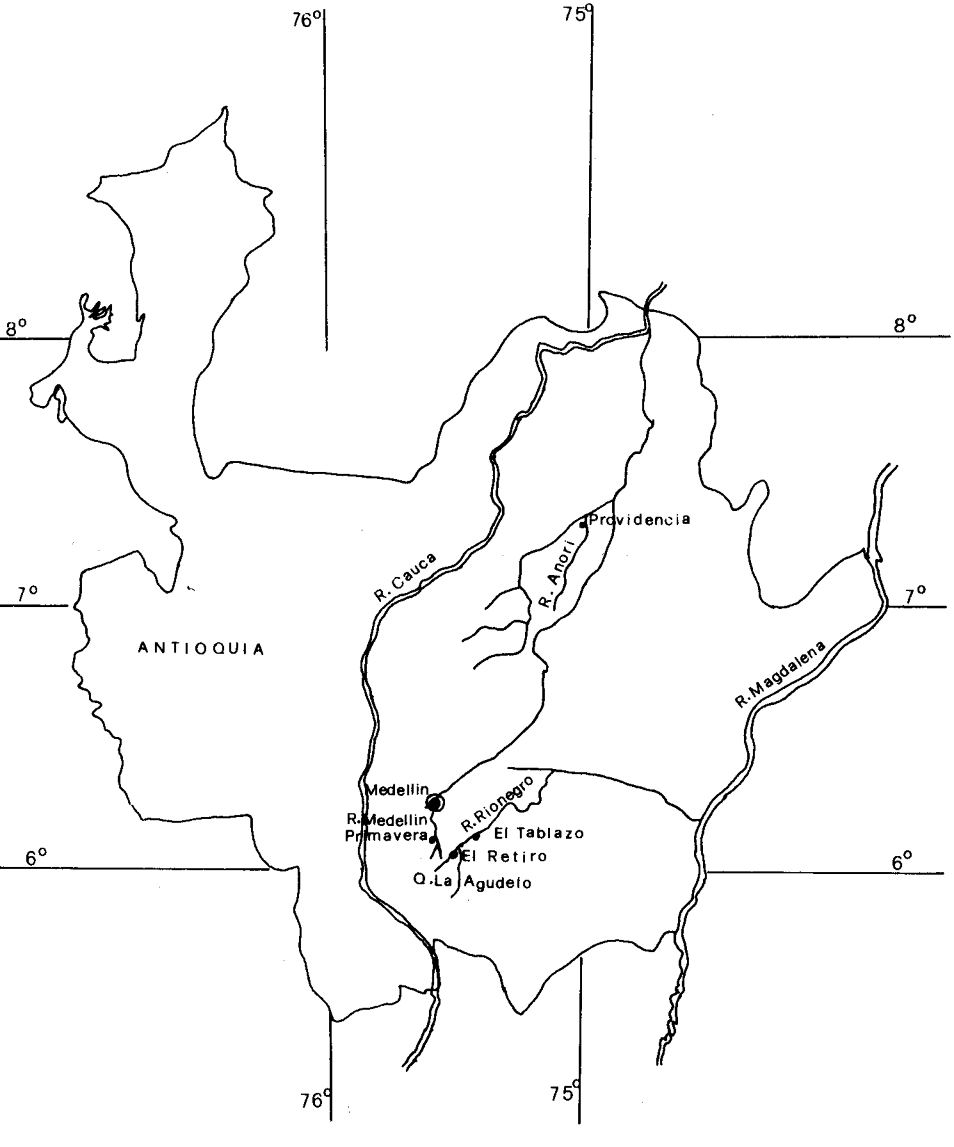


Fig. 2. Map of Antioquia, Colombia, showing the four sampling stations.

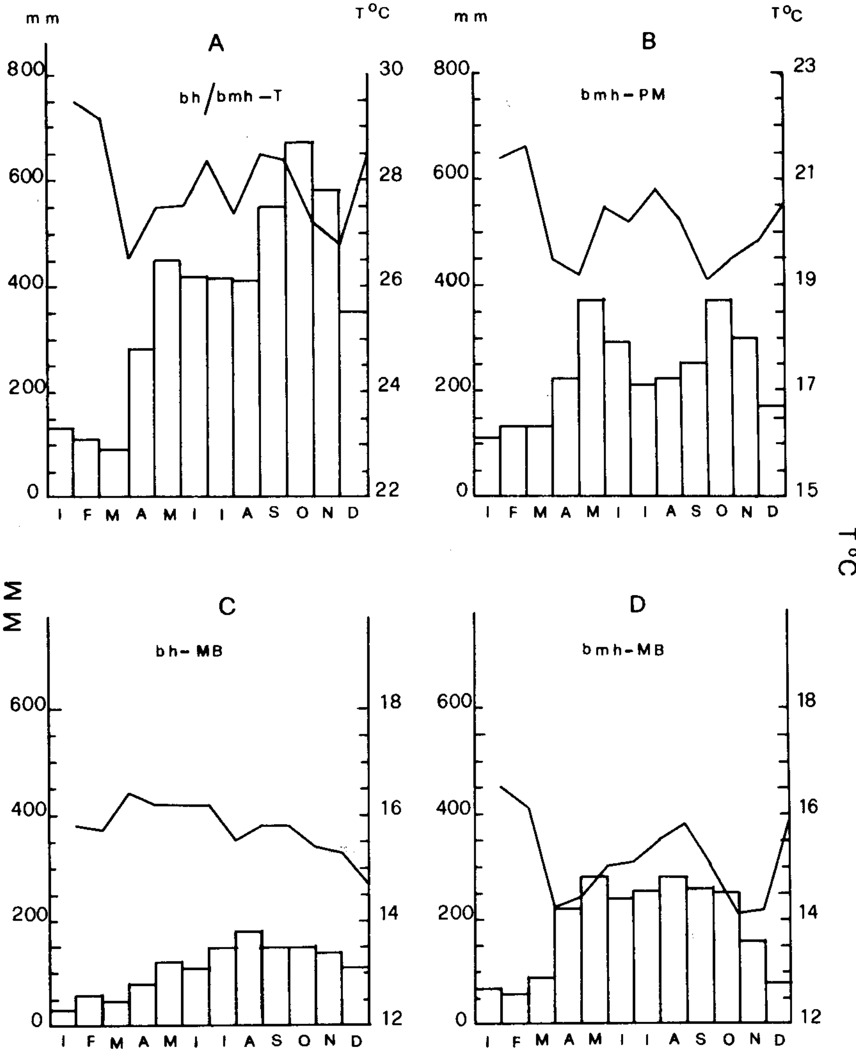


Fig. 3. Climatic characteristics of the areas in which are located the stations studied. A) Rio Anori (Providencia),B) Rio Medellin (Primavera), C) Rio Rionegro (El Tablazo), D) Quebrada La Agudelo (El Retiro).

METHODS AND MATERIALS

Samples in Rio Anori (Providencia) were taken every four months, from March,1973 to December,1975. This station was studied for a longer time with wider intervals between sampling dates. There are difficulties to travel to Providencia because it is located in a very isolated area. Samples from Rio Medellin (Primavera) were taken every month from November,1973 to October,1974. Samples from Rio Rionegro (El Tablazo) were taken from March,1975 to Februar,1976, and from Quebrada La Agudelo (El Retiro) from March,1975 to Februar,1976.

Physicochemical

A telethermometer YSI-Mod.42Sc was used to measure temperature. A HACH conductivity meter, Mod.2200, was used to measure conductivity in the field. Water samples for dissolved oxygen and carbon dioxide were collected by rotating the sampling botlle slowly just beneath the water surface and processed directly in the field. pH was also measured in the field with a portable pH meter. Turbidity was measured in the laboratory with a HACH turbidimeter. Nitrates and phosphates were analysed with a HACH colorimeter. Dissolved oxygen, carbon dioxide, hardness, and alkalinity were analysed following the Standard Methods (APHA,1963).

Biological

Biological samples were taken in shallow places by removing the bottom of the river with feet and collecting the nymphs with a hand screen. In deeper places a rifle net was used. The method of removing stones from the bottom and collecting the nymphs with small tweezers was also regulary used.
The samples were put into 70% alcohol for later laboratory

analyses. The photos herein included were taken with an Ortolux II microscope from Leitz. The entire nymphs were photographed with a Wild Photomicroscop M 400.
From August,1979 to August,1980 the gathered physicochemical data were tabulated and organized, and the biological material was keyed out in the Gesamthochschule, Kassel, Universität des Landes Hessen, and this dissertation was written.
Only nymphs of the studied Order of Ephemeroptera were collected because the main purpose of the present study is to use mayfly nymphs communities as indicators of water quality.
The classification of the material was carried out only to genus level, since the existing literature on this matter in Tropical America is still poor and incomplete.

RESULTS

Physicochemical

Temperature

One of the most striking characteristics of the tropical ecosystems is their high temperature constancy. Tables I, II,III, and IV show how in the present investigation the mean monthly temperature exhibits slight changes only ranging from one to two degrees. The temperature of the water depends, then, upon the altitude above sea level and is relatively constant throughout the year.

Dissolved Oxygen

The amount of oxygen in natural waters is directly related to temperature. Cold and unpolluted waters contain more oxygen than warm and unpolluted ones. Tables I and IV, and figure 4 show this relationship. The maximun dissolved oxygen content (10.5 mg/l) was found in Quebrada La Agudelo in October,1976 and the minimum (4.3 mg/l) in Februar,1974 in Rio Medellin.

Carbon Dioxide

The carbon dioxide values were in general low. The highest value (8.0 mg/l) was found in Rio Medellin in Februar,1973 and the lowest one (1.5 mg/l) in Quebrada La Agudelo in November,1976. The values had the tendency to increase with higher temperatures and pollution conditions (Fig.4).

pH

All the ecosystems studied showed a high stability in pH, most of then being on the neutral or slightly acid side. Only Rio Medellin showed striking changes ranging from 8.2 in November,1973 to 6.4 in Februar,1974 (Fig.5).

Conductivity

The lowest value of conductivity (7.5 mg/l) was found in Rio Anori in June,1973, and the highest (96.0 mg/l as NaCl) in Rio Rionegro in April,1975. This high value was detected only one time. In order to confirm it a chloride test was run. This situation may has been caused by farm activities in the area. This parameter ran parallel to nitrates and phosphate concentrations (Fig.6).

Turbidity

Values of turbidity were very low in Rio Anori and Quebrada La Agudelo and median in Rio Rionegro. The highest values were found in Rio Medellin, with a mean turbidity through the year of 30.64 JU. Figure 7 shows the tendency of this parameter at the four stations studied.

Hardness

All the ecosystems studied are composed of soft water. The lowest values of total hardness were found in Quebrada La Agudelo with a mean content of 8.4 mg/l. The highest values were reported in Rio Medellin with a mean content of 17.25 mg/l. Calcium and magnesium hardness were also measured showing in general half the values of the total hardness (Tables I,II,III, and IV).

Alkalinity

Alkalinity was a parameter that showed in general low values in all the stations studied. The lowest values were reported in Rio Anori with an annual mean value of 8.12 mg/l. The highest ones were reported in Rio Medellin with a mean value through the year of 21.70 mg/l (Fig.5).

Nitrates

This parameter was also low in general at all the stations studied. The lowest values (0.024 mg/l) were reported in Rio Rionegro in March,1975 and the highest ones (1.04 mg/l) in Rio Medellin in Februar,1974 (Fig.6).

Phosphates

This parameter was also relatively low in Rio Anori, Rio Rionegro, and Quebrada La Agudelo. Rio Medellin presented relatively high values the maximun being 0.5 mg/l in Februar, 1974 (Fig.6).

Biological

The Ephemeroptera

The Ephemeroptera or mayflies spend most of their life as aquatic nymphs. In most cases the adult stage lasts only from a few hours to a few days and their function is only for reproduction. These insects have been named Ephemeroptera which means "ephemeral" or brief, because of the brevity of their adult life.
Since apparently mayflies do not play any conspicuous role in the man-made economy these insects are considered at the first glance unimportant to study. But this impression is

TABLE I: Physicochemical data gathered from March 1973 to December 1975 in Rio Anori (Providencia). (Measurements are given in mg/l, unless stated in particular cases.)

	1973				1974				1975			
Parameter	March	June	Sept.	Dec.	March	June	Sept.	Dec.	March	June	Sept.	Dec.
Temperature ^{o}C	22.5	21.7	21.0	22.2	22.0	21.5	22.0	22.5	22.8	22.3	21.5	22.6
Diss. oxygen	7.5	8.4	8.2	8.1	7.6	8.5	8.3	8.0	7.8	8.3	8.1	7.7
Carbon dioxide	6.5	4.0	3.5	5.5	5.5	3.5	4.2	5.2	7.0	4.5	3.5	4.7
pH	6.9	6.7	6.8	6.7	6.9	6.8	6.7	6.8	6.9	6.8	6.7	6.8
Conductivity	10.5	7.5	9.0	9.5	11.2	8.1	8.5	9.2	10.7	8.6	8.4	9.8
Turbidity (UJ)	1.0	25.0	15.0	2.0	1.0	35.0	22.0	3.0	1.5	30.0	14.0	2.5
Hardness (total)	20.0	10.0	15.0	20.0	15.0	10.0	12.0	15.0	20.0	10.0	12.0	18.0
Hardness (Ca)	10.0	5.0	7.5	10.0	7.5	5.0	6.0	7.5	10.0	5.0	6.0	9.0
Hardness (Mg)	10.0	5.0	7.5	10.0	7.5	5.0	6.0	7.5	10.0	5.0	6.0	9.0
Alkalinity	8.3	7.8	7.9	8.1	8.5	7.9	8.0	8.2	8.4	8.1	8.0	8.3
Nitrates	0.45	0.12	0.22	0.35	0.32	0.11	0.15	0.23	0.65	0.45	0.36	0.54
Phosphates	0.03	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.03	0.01	0.02	0.02

TABLE II: Physicochemical data gathered from November, 1973 to October, 1974 in Rio Medellin (Primavera). (Measurements are given in mg/l, unless stated in particular cases.)

	1973					1974						
Parameter	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sept.	Oct.
Temperature °C	19.5	19.8	21.5	21.4	20.2	20.1	20.0	20.8	21.1	20.2	20.1	19.8
Diss. oxygen	7.2	6.1	5.2	4.3	5.4	5.8	6.1	5.4	5.6	5.7	5.7	6.5
Carbon dioxide	4.2	5.7	7.5	8.0	7.2	6.5	5.8	6.2	6.5	6.1	5.4	4.8
pH	8.2	7.7	6.5	6.4	6.9	7.1	7.2	6.9	7.4	7.6	7.8	7.9
Conductivity	30.0	35.0	55.0	54.0	35.0	30.0	38.0	40.0	45.0	43.0	38.0	37.0
Turbidity (UJ)	80.0	65.0	7.5	4.2	15.0	25.0	15.0	14.0	18.0	24.0	35.0	65.0
Hardness (total)	12.0	15.0	30.0	30.0	15.0	10.0	10.0	15.0	20.0	20.0	15.0	15.0
Hardness (Ca)	6.0	8.0	15.0	15.0	8.0	5.0	5.0	8.0	10.0	10.0	8.0	8.0
Hardness (Mg)	6.0	7.0	15.0	15.0	7.0	5.0	5.0	7.0	10.0	10.0	7.0	7.0
Alkalinity	15.0	25.0	30.0	35.0	20.0	18.0	15.0	22.0	25.5	20.0	20.0	15.0
Nitrates	0.55	0.65	0.92	1.04	0.82	0.72	0.85	0.92	0.88	0.65	0.63	0.58
Phosphates	0.06	0.09	0.45	0.50	0.40	0.09	0.04	0.45	0.41	0.42	0.06	0.05

TABLE III: Physicochemical data gathered from March, 1975 to February, 1976 in Rio Rionegro (El Tablazo).
(Measurements are given in mg/1, unless stated in particular cases.)

	1975										1976	
Parameter	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Temperature ^{o}C	17.0	17.0	17.0	17.5	17.5	17.0	17.0	19.0	18.0	19.0	20.0	19.0
Diss. oxygen	7.0	8.3	6.9	7.2	6.7	7.0	7.0	7.0	5.0	7.1	7.4	5.6
Carbon dioxide	2.0	4.0	4.0	6.0	4.0	6.0	2.0	6.0	4.0	6.0	6.0	4.0
pH	6.8	7.3	6.9	7.05	6.73	7.2	7.12	6.78	6.5	7.0	7.6	6.75
Conductivity	33.0	96.0	23.0	18.0	17.0	22.0	48.0	19.0	21.0	18.0	21.0	31.0
Turbidity (UJ)	8.0	2.0	30.0	20.0	37.0	10.0	9.0	19.0	8.0	8.0	1.0	25.0
Hardness (Total)	20.0	20.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Hardness (Ca)	10.0	10.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Hardness (Mg)	10.0	10.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Alkalinity	15.0	15.0	15.0	10.0	10.0	10.0	15.0	10.0	15.0	10.0	20.0	15.0
Nitrates	0.024	1.01	0.44	0.53	1.18	0.92	0.06	0.52	0.63	0.31	0.26	0.31
Phosphates	0.46	0.02	0.07	0.04	0.09	0.03	0.03	0.02	0.04	0.02	0.01	0.01

TABLE IV: Physicochemical data gathered from March, 1975 to February, 1976 in Quebrada La Agudelo (El Retiro). (Measurements are given in mg/l, unless stated in particular cases.)

Parameter	1975										1976	
	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Temperature °C	17.2	17.0	17.0	17.1	16.5	16.4	16.3	16.1	16.5	16.8	17.0	17.1
Diss. oxygen	8.9	8.4	8.7	8.8	9.5	9.8	10.2	10.5	10.2	9.5	8.4	8.6
Carbon dioxide	4.0	4.5	4.6	4.2	3.7	3.5	2.5	2.3	1.5	2.5	4.0	3.8
pH	6.85	6.9	6.9	6.8	6.75	6.75	6.7	6.7	6.7	6.7	6.8	6.8
Conductivity	13.8	17.4	14.4	13.3	12.1	12.2	11.2	10.5	10.3	10.1	11.3	12.8
Turbidity (UJ)	2.0	2.5	3.5	1.5	1.8	1.9	2.2	8.5	7.5	3.5	1.0	1.0
Hardness (Total)	7.0	7.0	8.0	8.0	9.0	10.0	9.0	8.0	7.0	8.0	10.0	10.0
Hardness (Ca)	4.0	4.0	4.0	4.0	5.0	5.0	5.0	4.0	4.0	4.0	5.0	5.0
Hardness (Mg)	3.0	3.0	4.0	4.0	4.0	5.0	4.0	4.0	3.0	4.0	5.0	5.0
Alkalinity	10.0	10.0	9.0	8.0	8.0	8.0	9.0	10.0	10.0	8.0	9.0	9.0
Nitrates	0.35	0.30	0.38	0.41	0.43	0.44	0.25	0.20	0.25	0.31	0.52	0.51
Phosphates	0.03	0.03	0.04	0.04	0.04	0.05	0.03	0.03	0.02	0.03	0.04	0.04

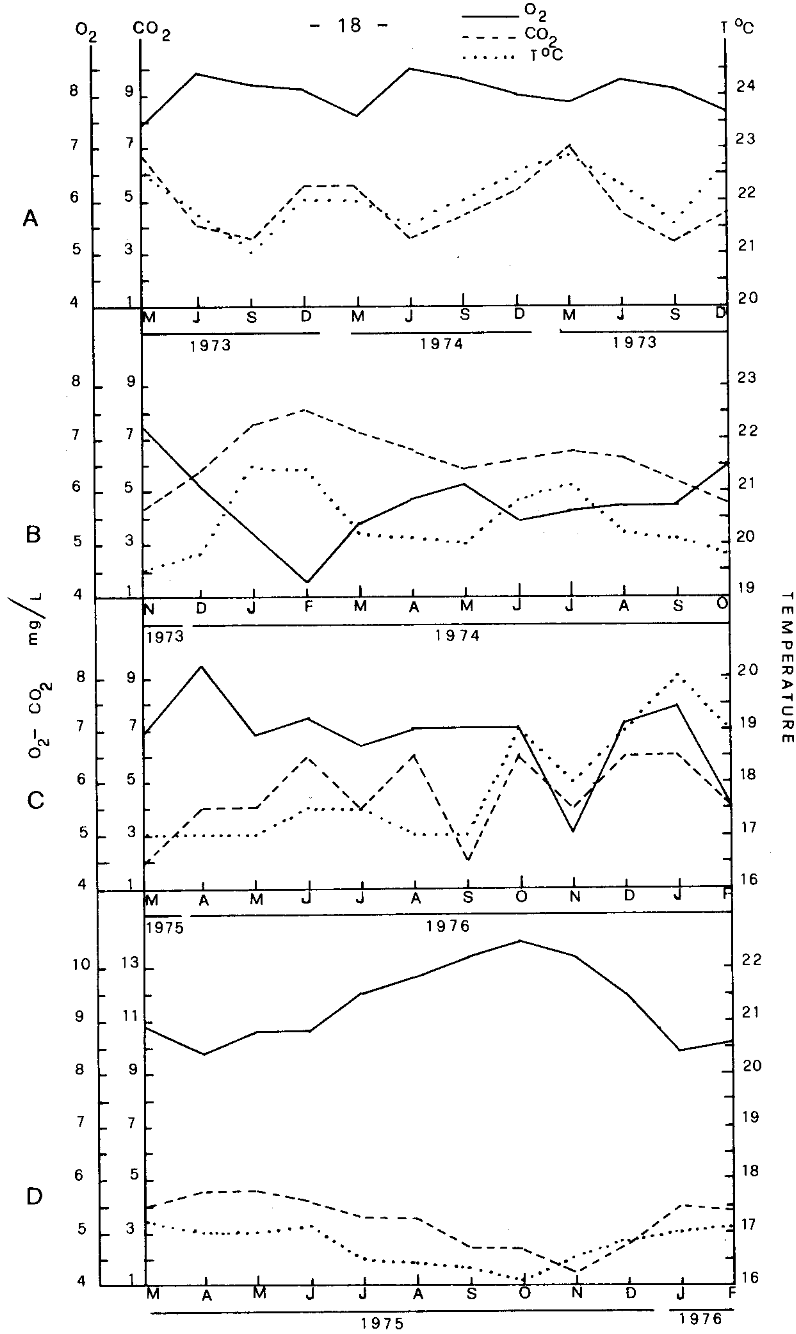


Fig. 4. Mean monthly oxygen, carbon dioxide, and temperature in the four stations studied. A) Rio Anori, B) Rio Medellin, C) Rio Rionegro, D) Quebrada La Agudelo.

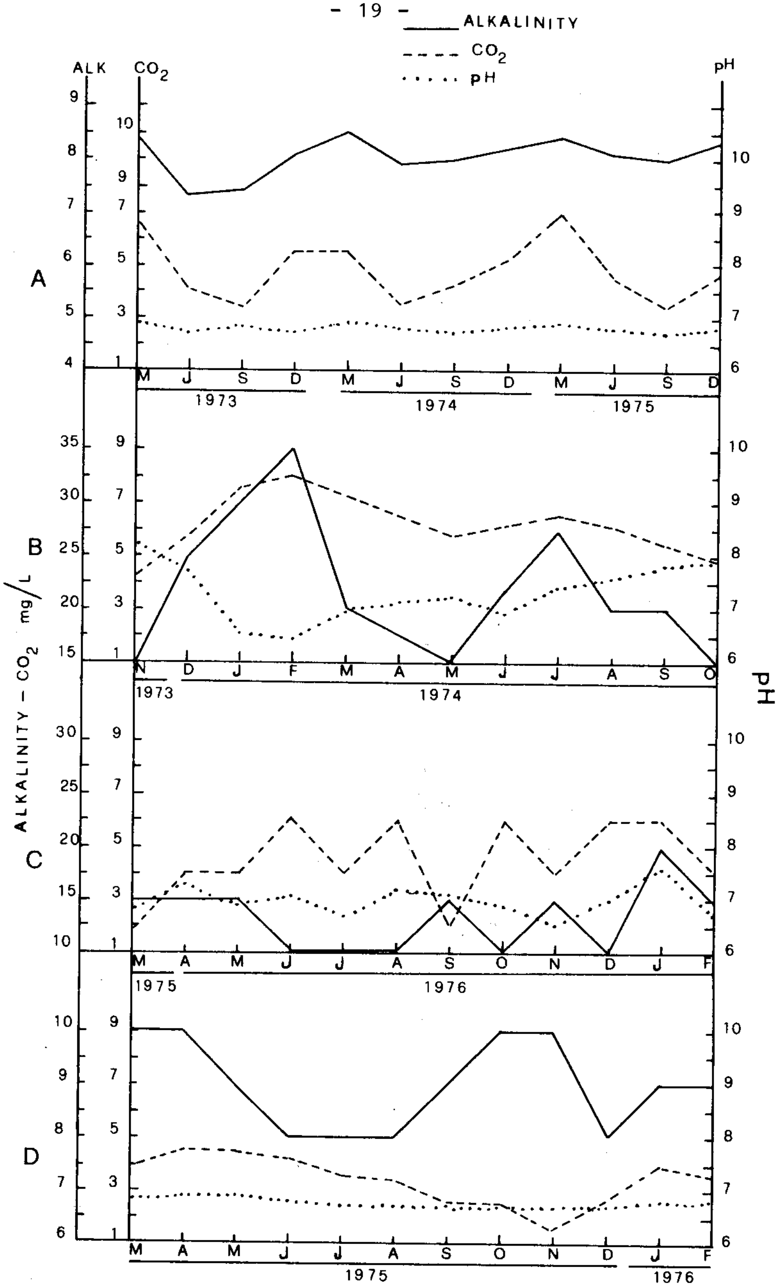


Fig. 5. Mean monthly alkalinity, carbon dioxide, and pH in the four stations studied. A) Rio Anori, B) Rio Medellin, C) Rio Rionegro, D) Quebrada La Agudelo.

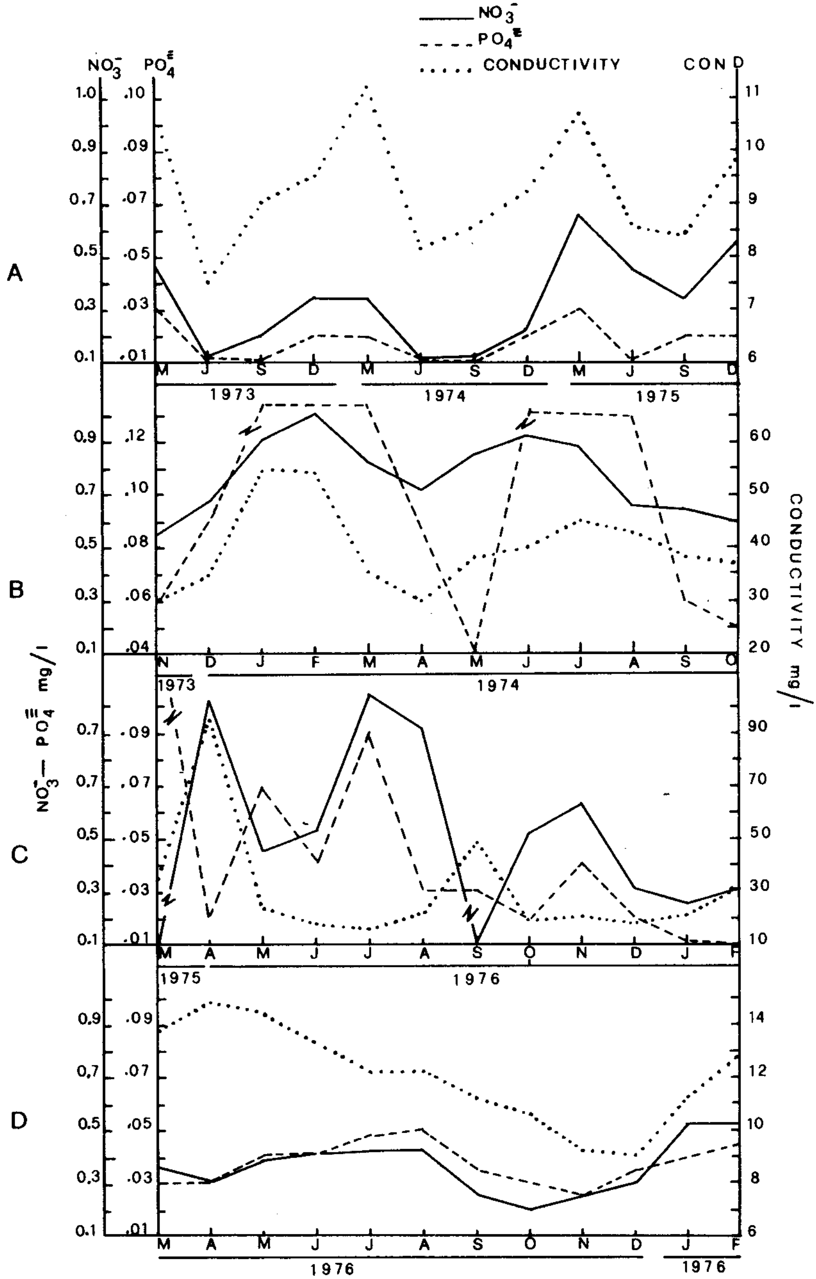


Fig. 6. Mean monthly nitrates, phosphates, and conductivity in the four stations studied. A) Rio Anori, B) Rio Medellin, C) Rio Rionegro, D) Quebrada La Agudelo.

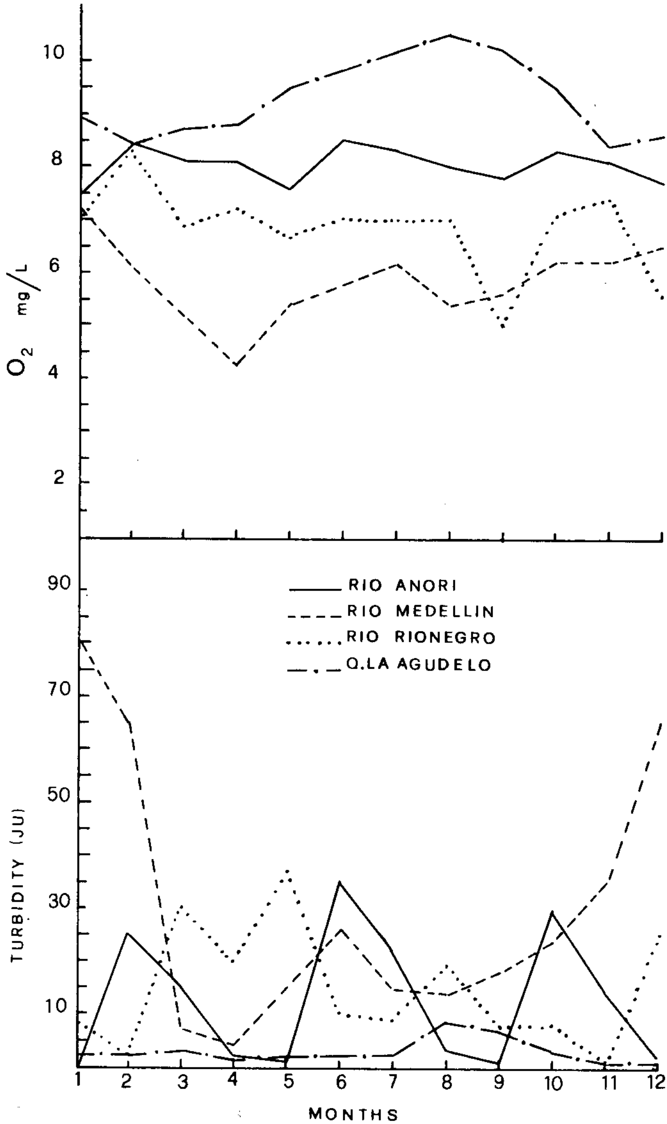


Fig. 7. Above: changes in oxygen; below: changes in turbidity through the time in the four stations studied.

altogether erroneous. BERNER (1950) stated that "the entire economy of aquatic life is intimately bounded up with the presence and abundance of mayflies, and it has been demostrated time and again that these insects in both immature and adult stages, constitute an important item in the diet of many species of fish, or in that of other organisms that in turn are eaten by fish". More recently, ZELINKA (1977) has estimated an average production in running waters of 200 to 570 kg per hectare per year, which means a comparatively high production and it confirms the importance of this component of zoobenthos for fish production in running waters.

Another practical aspect of the study of mayflies and aquatic insects in general is that they have been used in the past years as indicators of water pollution (WILHM & DORRIS,1966,1968; RANSOM,1969; ROLDAN et.al.,1973; PEREZ & ROLDAN,1978).

The above commentars are related to what we can call the applied aspect of the study of mayflies. But the taxonomic aspect is not only important but also basic for ecological studies, and this is the reason why mayflies were selected for special study in the present investigation.

Taxonomy

Most of taxonomic studies published to this date consist of isollated descriptions of genera and species from different regions of Central and South America. HUBBARD & PETERS (1977) present quite a complete bibliography about the Ephemeroptera of Sothern South America.

For the Neotropical America the information is still scattered. For this reason it was considered important to give a general status of the mayflies that have been reported from this region. For this purpose, the Neotropics, Central and Northern South America were considered (Fig.1). The system of

classification in the present study is the one proposed by EDMUNDS et.al. (1976). In general, the keying out of the material fitted quite well for families and genera. But it was not possible to key out the material to species level, since there are not yet usefull keys for this purpose. Some authors have developed keys for the species of particular genera, but there is no uniformity for the criteria used. For example, for the genus Baetodes NEEDHAM & MURPHY, 1924; MAYO (1968, 1973, 1977) prefer to use the mouth parts as important taxonomic characteristics. COHEN & ALLEN (1977, 1978) prefer the degree of coloration and other external structures as taxonomic characteristics for their classification.
On the other hand, some authors such as TRAVER (1946, 1947, 1950) have published several papers about mayflies of tropical America, but most of her classifications are based on adults.
In view of this difficulty, the existing literature was considered inadequate for a correct species classification. Even for genera an exact determination was difficult in some cases (or impossible). EDMUNDS et.al. (1976) state in many parts of their book that there is still much investigation to be done in the neotropical mayfly fauna, and keys must be constructed on regional bases.
Table V gives a list of the famlies and subfamilies that have been reported from Central and Northern South America. Based on the classification proposed by EDMUNDS et.al. (1976) it can be seen that from 18 mayfly families existing in the world 11 are reported from Central and South America.
Since one of the objectives of the present study is to set the base for future research in this field in the area of Antioquia and similar ecological regions, a complete nymph of Thraulodes, its mouth parts, and a claw are drawn (Fig.8). Also, figure 9 shows some taxonomical aspects usefull for the identification of neotropical mayflies.

FAMILIES AND GENERA DEALT WITH IN THE PRESENT STUDY

Five families and ten genera were found in the present study. An unidentified "Leptophlebiid" nymph is also reported. In these genera, 23 unidentified species are included. For only one species, Euthyplocia hecuba (HAGEN), information was considered sufficient to key it out to the species level. Tables VI and VII give a summary of the families and genera herein reported and the number of individuals collected at each ststion. From these numbers the percentages for each species were stimated (Table VIII).

TABLE V: Families and Subfamilies of Ephemeroptera reported from Central and Northern South America.

Family	Subfamily	Central America	N.- South America
Siphlonuridae	Isonichiinae	X	
Baetidae	________	X	X
Oligoneuriidae	Oligoneuriinae	X	X
Heptageniidae	Heptageniinae	X	X
Leptophlebiidae	________	X	X
Ephemerellidae	Melanemerellinae		X
Tricorythidae	Leptohyphinae	X	X
Caenidae	________	X	X
Euthyplociidae	________	X	X
Ephemeridae	Ephemerinae	X	X
Polymitarcidae	Campsurinae	X	X

TABLE VI: Families and genera dealt with in the present study

Family	Genus	Number of Species
BAETIDAE	Baetis sp.	4
	Baetodes sp.	4
	Dactylibaetis sp.	1
OLIGONEURIIDAE	Lachlania sp.	2
LEPTOPHLEBIIDAE	Thraulodes sp.	5
	Hermanellopsis sp.	1
	"Leptophlebiid" nymph	1
TRICORYTHIDAE	Leptohyphes sp.	3
	Tricorythodes sp.	1
EUTHYPLOCIIDAE	Euthyplocia sp.	1
	Campylocia sp.	1

TABLE VII: Number of individuals collected in the four stations herein studied and the percentage in which each genus is represented in the total community.

SPECIES	NUMBER OF INDIVIDUALS					
	Rio Anori	Rio Medellin	Rio Rionegro	Quebrada La Agudelo	Total	%
<u>Baetis</u> (4 species)	80	4	28	28	140	8,39
<u>Baetodes</u> (4 species)	238	-	37	13	288	17,23
<u>Dactylobaetis</u> (1 species)	60	12	128	-	200	11,97
<u>Lachlania</u> (2 species)	-	-	-	16	16	0,96
<u>Thraulodes</u> (5 species)	161	-	39	60	260	15,56
<u>Hermanellopsis</u> (1 species)	1	-	-	-	1	0,06
"Leptophlebiid" nymph	4	-	-	-	4	0,23
<u>Leptohyphes</u> (3 species)	260	189	194	21	664	39,74
<u>Tricorythodes</u> (1 species)	-	-	96	-	96	5,74
<u>Euthyplocia hecuba</u>	1	-	-	-	1	0,06
<u>Campylocia</u> (1 species)	1	-	-	-	1	0,06
Total	806	203	522	138	1.671	100,00

TABLE VIII : Number of individuals collected and the percentage in which each species is represented for each genus in the different sampling stations.

SPECIES	No.ind.for each species	% each sp. for each gen.	Rio Anori		R. Medellin		R. Rionegro		Q. La Agudelo	
			No.	%	No.	%	No.	%	No.	%
1. *Baetis* sp No. 1	64	45.71	64	100	-	-	-	-	-	-
2. *Baetis* sp No. 2	32	22.85	4	12.5	-	-	-	-	28	87.5
3. *Baetis* sp No. 3	24	17.14	-	-	4	16.67	20	83.33	-	-
4. *Baetis* sp No. 4	20	14.30	12	60.0	-	-	8	40.0	-	-
5. *Baetodes* sp No. 1	184	63.88	166	90.16	-	-	18	9.84	-	-
6. *Baetodes* sp No. 2	56	19.44	24	42.85	-	-	19	35.15	13	22.0
7. *Baetodes* sp No. 3	28	9.72	28	100	-	-	-	-	-	-
8. *Baetodes* sp No. 4	20	6.96	20	100	-	-	-	-	-	-
9. *Dactylobaetis* sp	200	100	60	30.0	12	6.0	128	64.0	-	-
10. *Lachlania* sp No. 1	10	60.0	-	-	-	-	-	-	10	100
11. *Lachlania* sp No. 2	6	40.0	-	-	-	-	-	-	6	100
12. *Thraulodes* sp No.1	96	36.92	61	63.3	-	-	19	20.0	16	16.7
13. *Thraulodes* sp No.2	72	27.7	57	78.9	-	-	-	-	15	21.1
14. *Thraulodes* sp No.3	68	26.15	34	50	-	-	20	30.0	14	20.0

TABLE VIII (Continue):

SPECIES	No.ind.for each species	% each sp. f.each gen.	Rio Anori		R.Medellin		R. Rionegro		Q.La Agudelo	
			No.	%	No.	%	No.	%	No.	%
15. Thraulodes sp No. 4	20	7.7	5	25.0	-	-	-	-	15	75.0
16. Thraulodes sp No. 5	4	1.53	4	100	-	-	-	-	-	-
17. Hermanellopsis sp	1	100	1	100	-	-	-	-	-	-
18. "Leptophlebiid" nymph	4	100	4	100	-	-	-	-	-	-
19. Leptohyphes sp No. 1	464	69.89	188	40.55	113	24.32	150	32.43	13	2.7
20. Leptohyphes sp No. 2	148	22.28	36	24.34	76	51.35	28	18.91	8	5.4
21. Leptohyphes sp No. 3	52	7.83	36	69.23	-	-	16	30.77	-	-
22. Tricorythodes sp	96	100	-	-	-	-	96	100	-	-
23. Euthyplocia hecuba	1	100	1	100	-	-	-	-	-	-
24. Campylocia sp	1	100	1	100	-	-	-	-	-	-

KEY TO NYMPHS

The present key follows the model proposed by EDMUNDS et.al. (1976). It was greately reduced and adapted for the known neotropical mayflies.

1 -Mandibles with large tusks projecting forward and visible from above head (Figs.30-32)........2

-Mandibles without such tusks (Figs.10-12).......4

2(1) -Fore tibiae and tarsi more or less flattened, adapted for burrowing (Fig.9A); abdominal gills held dorsally....................................3

-Fore tibiae and tarsi cylindrical, unmodified (Fig.31B); abdominal gills held laterally; tusks with numerous long setae.......Euthyplocidae, 22

3(2) -Ventral apex of hind tibiae projected into distinct acute point (Fig.9B); mandibular tusks curved upward apically as viewed laterally.......... ....Ephemeridae

-Ventral apex of hind tibiae rounded (Fig.9C); mandibular tusks curved downward apically as viewed laterally...............Polymitarcidae, 23

4(1) -Forelegs with double row of long setae on inner surface (Fig.9D); tufts of gills present at bases of maxillae; gills maybe present at bases of fore coxae......................................5

-Forelegs with setae other than above; gill tufts absent from bases of maxillae and fore coxae....6

5(4) -Gills ventral on abdominal segment 1 (Fig.18A); gill tufts absent from bases of fore coxae .... Oligoneuriidae, 17

-Gills dorsal on abdominal segment 1; gill tufts present at bases of coxae (Fig.9D) ....Siphlonuridae, Isonichia

6(4) -Gills on abdominal segment 2 operculate, covering succeding pairs (Fig.9E) 7

-Gills on abdominal segment 2 neither operculate nor semioperculate, either similar to those on succeding segments or absent (Fig.12A, 20D).....9

7(6) -Gills on abdominal segment 2 triangular, semitriangular, or oval, not meeting medially (fig. 29D); gill lamellae on segments 3-6 simple or bilobed, without margins fringed............... ....Tricorythidae, 20

-Gills on the abdominal segment 2 quadrate, meeting or almost meeting medially (Fig.9F); gill lamellae on segments 3-6 with margins fringed... 8

8(7) -Mesonotum without anterolateral lobes (Fig.9G); operculate gills not fused medially; developing hind wing pads absent....... Caenidae, 21

-Mesonotum and gills not as above............. 9

9(8) -Gills absent on abdominal segment 2, rudimentary or absent on segment 1, andpresent or absent on segment 3 (Fig.9H); gills on segments 3-7 or 4-7 consist of anterior (dorsal) oval lamella and posterior (ventral) lamella with numerous lobes; paired tubercles often present on abdominal terga....... Ephemerellidae, Ephemerella

-Gills on abdominal segments 1-5, 1-7, or 2-7; paired tubercles rarely present on abdominal terga 10

10(9) -Nymph distinctly flattened; head prognatus, eyes and antenae dorsal (Fig.20A) 11

-Nymph not flattened, being more cylindrical; head hypognatus, eyes and / or antenae lateral, anterolateral, or on front of head (Figs. 10A, 12A, 14A) 12

11(10) -Abdominal gills of single lamellae, usually with fibrilliform tufts at near bases (Fig.9I), rarely pointed and rarely with narrow lanceolate branch making gills appear forked; mandibles concealed beneath flattened head capsule; labial palpi two-segmented .... Heptageniidae

-Abdominal gills either forked (Fig. 9J,K; 23A) formed of two lamellae with margins fringed or terminated in filaments or points, never formed of a lamella and fibrilliform tuft; mandibles visible and forming part of upper surface of head; labial palpi three-segmented ....Leptophlebiidae, in part 12

12(11) -Abdominal gills on segments 2-7 either forked (Fig.23A), in tufts, with all margins fringed or with double lamellae terminate in filaments or points ....Leptophlebiidae, in part, ... 18

-Abdominal gills not as above; gills either obovate, cordate, or subcordate (Fig.10D), lamellae either single, double, or triple, never terminating in filaments or points; inner margin of gills usually entire, rarely finely dissected.. 13

13(12) -Antenae short, lenght less than twice width of head (Fig. 9M); posterolateral projections present and usually prominent on abdominal segments 8-9, glossae and paraglossae of labium short and broad .... Siphlonuridae

-Antenae long, lenght more than three times width of head (Fig. 9L, 12A); posterolateral projections usually absent or small to moderately developed on segments 8-9; glossae and paraglossae of labium long and narrow (Fig.10C).....Baetidae, 14

14(13) -Claws distinctly spatulate with large denticles (Fig. 16B), tarsi distinctly bowed.............. .... Dactylobaetis

-Claws sharply pointed; denticles, if present, smaller and ventral (Fig. 12B) 15

15(14) -Abdominal gills present on segments 1-5 only, terminal filament ususally short; caudal filaments bare or with only few setae.... Baetodes

-Abdominal gills present on segments 1-7 or 2-7, held laterally or somewhat dorsally; caudal filaments usually with fringe of hairs on inner margin; tubercles or tufts of setae absent from abdomen 16

16(15) -terminal filament shorter and thiner than cerci; spreadly distributed .... Baetis

-Terminal filament absent.................. 17

17(5) -Two caudal filaments present; lamellae portion of abdominal gills 2-7 oval, fibrilliform portion well developed (Fig.18).......... Lachlania

-Three caudal filaments present; lamellate portion of abdominal gills 2-7 lanceolate, fibriliform portion absent .... Homoeoneuria

18(12) -Labrum about two-thirds as wide as head (Fig.20B), distinctly wider than clypeus; gills variable, but each lamellae up to one-fourth as broad as long; posterolateral spines present on abdominal segments 2-9, usually small on segments 2-3 or 2-4; widly distributed .... Thraulodes

-Labrum less than half as wide as head, about as wide as clypeus (Fig. 22C); each gill lamellae usually no more than one-eight as broad as long; poeterolateral spines usually present on abdominal segments 6-9 or 8-9 or on 9 only.......... 19

19(18) -Developing hind wing pads present; posterolateral projections on abdominal segments 8-9 .... Hermanellopsis

-Developing hind wings pads absent; posterolateral projections on abdominal segments 6-9 .... Hagenulopsis

20(7) -Femora with long setae (Fig.9N); operculate abdominal gill 2 triangular or subtriangular in shape, over two-thirds as wide as long (Fig.29D) .... Tricorythodes

-Femora with spines (Fig.26B); operculate abdominal gill 2 oval in shape, less than two-thirds as wide as long;widly distributed .... Leptohyphes

21(8) -Head with three prominent ocellar tubercles; maxillary and labial palpi two-segmented .... Brachycerus

-Head without ocellar tubercles; maxillary and labial palpi three segmented .... Caenis

22(2) -Apical extension of tibiae of forelegs nearly half length of tarsi; tarsi extending beyond bases of claws (Fig.31B); antenae three times longer than mandibular tusks ....Euthyplocia

-Apical extension of tibiae of forelegs one-fourth length of tarsi (Fig.32C); tarsi with claws at apex; antenae shorter, rarely longer than mandibular tusks .... Campylocia

23(3) -Mandibular tusks with single prominent subapical tubercle on median margin although another tubercle may also occur basal to this........ .... Tortopus

-Mandibular tusks with a prominent basal or subbasal tubercle on median margin and several to many smaller apical crenations ...... Campsurus

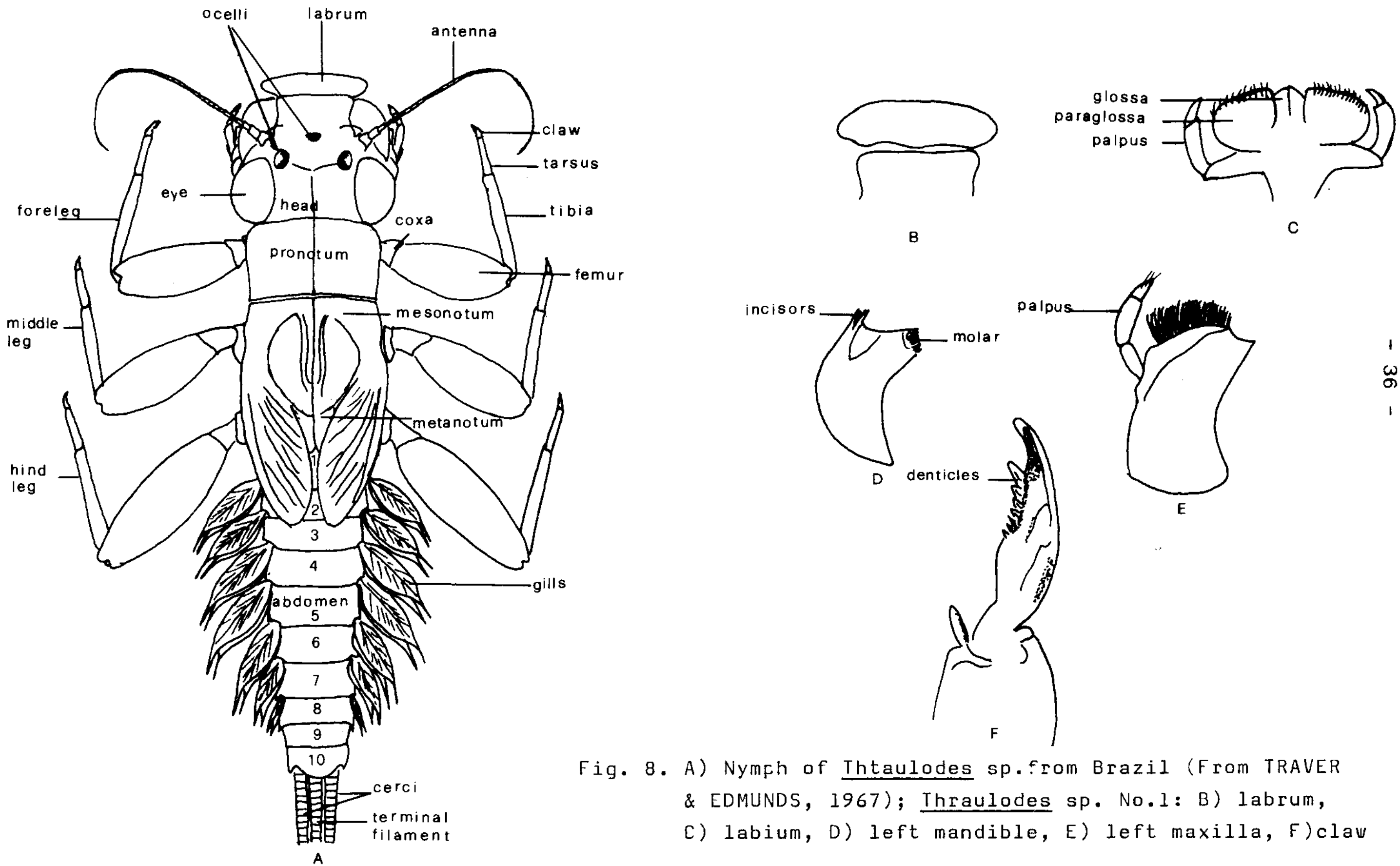


Fig. 8. A) Nymph of <u>Thtaulodes</u> sp. from Brazil (From TRAVER & EDMUNDS, 1967); <u>Thraulodes</u> sp. No.1: B) labrum, C) labium, D) left mandible, E) left maxilla, F)claw

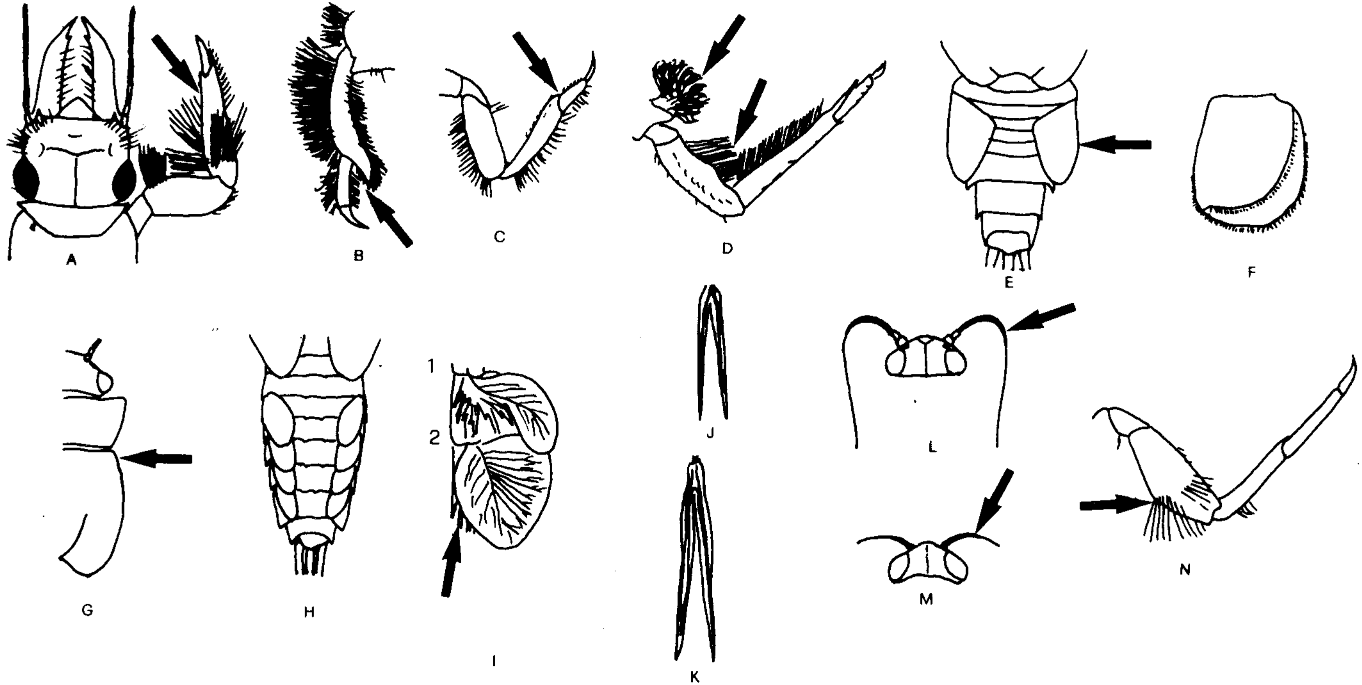


Fig. 9. Some taxonomical characteristics of Ephemeroptera. A) head and foreleg, Tortopus sp; B) hind leg, Hexagenia sp.; C) hind leg, Campsurus sp.; D) foreleg, Isonichia sp.; E) abdomen, Tricorythodes minutus; F) gill, Caenis sp.; G) head and thorax, Caenis simulans; H) abdomen, Ephemerella (Serratella) tibialis; I) gill seg.1-2, Heptagenia sp; J) gill 4, Homothraulus sp.; K) gill 4, Hagenulopsis sp.; L) head, Baetis sp.; M) head Siphlonurus sp.; N) foreleg Tricorythodes minutus (After EDMUNDS et.al.,1976).

FAMILY BAETIDAE

Genus *Baetis* LEACH, 1915

This genus was described by LEACH in 1815 and it was one of the first known Ephemeropterans. The type species was named *Baetis fuscatus* (LINNAEUS) and the type locality was Sweden.

The first comprehensive work done on this genus was carried out by NEEDHAM & MURPHY (1924) who reported five species from Peru, some of them described from adults. TRAVER (1944) reported a Baetid form as *Baetis* sp. from Brazil, and DEMOULIN (1955) reported another *Baetis* sp. also from Brazil. ILLIES (1964) reported *Baetis* sp. from Peru and he refered to this genus as a cosmopolitan genus found from the low land Amazon to the upper Andes. PACKER (1966) reported a *Baetis* sp. from Honduras. ROBACK (1966) reported three unnamed species from Peru . EDMUNDS et al. (1976) give extense information about the genus *Baetis* in North and Central America. Out of 62 species reported only two are from Central America and there is no information on country of origin. Table IX summarizes the present knowledge of this genus in the Neotropics.

Although *Baetis* is a cosmopolitan genus, it is one of the more poorely known Ephemeropteran genera in the Neotropics. At present there is no key available for identification of the species. EDMUNDS et al. (1976) state that "in North and Central America this important genus will have to be studied most certainly in great detail, and keys will have to be contructed on a regional basis." Accordingly we can say the same for tropical America.

In the present study four species are reported.

Baetis sp. No.1 (Fig. 10-11)
Material: 64 nymphs

Body length 5,0-6,0 mm; cerci 2,0-3,0mm; general coloration yellow-brown; gills without tracheal branches; claws with 11-12 teeth diminishing in size gradually rearward; mouth parts as in figure 10 and 11.
From the *Baetis* collected in the present study, 45,71% belongs to this species, and all of them were found in Rio Anori (Providencia). According to this result this species prefers to live in clear water, so it may be regarded as indicator of clean water.

Baetis sp. No.2 (Fig. 12A)
Material: 32 nymphs

Body length 7.0-8,0 mm; cerci 3,0-4,0 mm; general coloration yellow-brown with dark brown markings in abdominal segments 2-3 and 6-7; claws with 9-10 teeth distributed in a similar way as in *Baetis* No.1. The main difference from *Baetis* No.1 is in the body size and in the coloration pattern (Fig. 12A). From the *Baetis* collected, 22,85% belongs to this species, and from this percentage, 87,5% was found in Q. La Agudelo and 12,5% in Rio Anori (Providencia). According to this, this species prefers to live in clear water, both in lowlands as in the mountains.

Baetis sp. No.3 (Fig. 13)
Material: 24 nymphs

Body length 4.0-5.0 mm; cerci 1.5-2.0 mm; general coloration yellow-brown; claws with 18-20 teeth, all of them of the same length; mouth parts as in figure 13. Figure 13 shows the most important characteristics of this species.
From the *Baetis* collected, 17,14% belongs to this species, and from this percentage, 83,33% was found in Rio Rionegro (El Tablazo) and 16,67% in Rio Medellin (Primavera), both

of them are moderately polluted rivers. Thus, this species may be regarded as indicator of moderate polluted water but still with enough oxygen all year round.

Baetis sp. No.4 (Fig. 12 B,C,D)
Material: 20 nymphs

Body length 7,0-8,0 mm; cerci 3,0-4,0 mm; torax dark-brown; abdomen from red-brown to yellow-brown, with transverse dark-brown bands in all segments; claws with 9-10 teeth diminishing in size as in *Baetis* sp. No.1 (Fig. 12 B,C,D). From the *Baetis* collected, 14,30% belongs to this species, and from this percentage, 60,0% was found in Rio Anori (Providencia) and 40,0% in Rio Rionegro (El Tablazo). This means that this species may have a moderate range of adaptability to pollution conditions.

TABLE IX: Species of the genus Baetis LEACH reported in Central and Northern South America.

Species	Country		
	Brazil	Honduras	Peru
x *B. dryops* NEEDHAM & MURPHY			X
x *B. melleus* NEEDHAM & MURPHY			X
B. peruvianus NEEDHAM & MURPHY			X
x *B. socius* NEEDHAM & MURPHY			X
x *B. tantillus* NEEDHAM & MURPHY			X
Baetis sp, No. 1 NEEDHAM & MURPHY, 1924			X
Baetis sp, No. 2 NEEDHAM & MURPHY, 1924			X
Baetis sp TRAVER, 1944	X		
Baetis sp DEMOULIN, 1955	X		
Baetis sp ILLIES, 1964			X
Baetis sp PACKER, 1966		X	
Baetis sp. 1, 2 and 3 ROBACK, 1966)			X

x Species described from adults

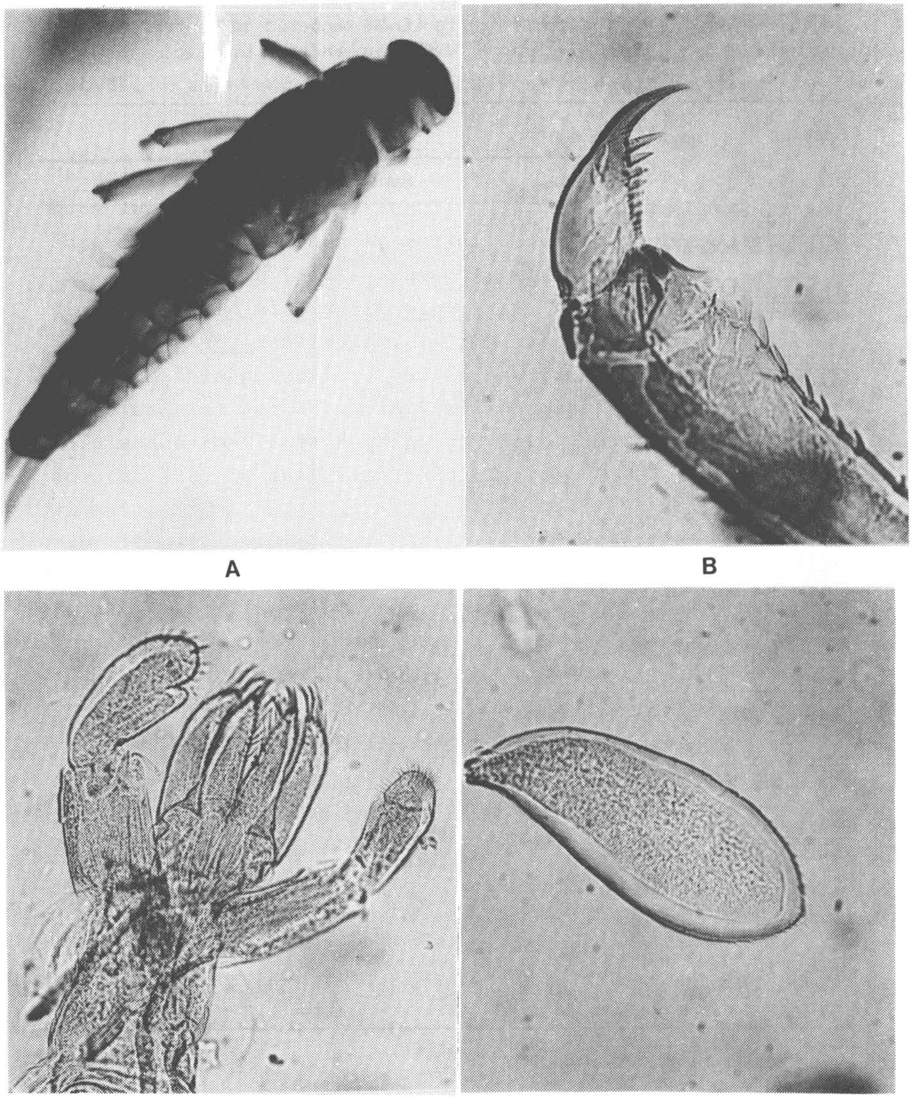
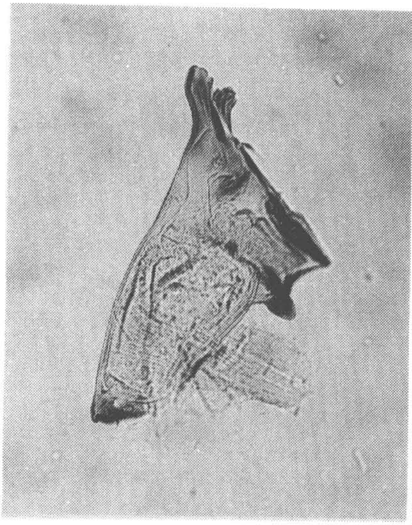
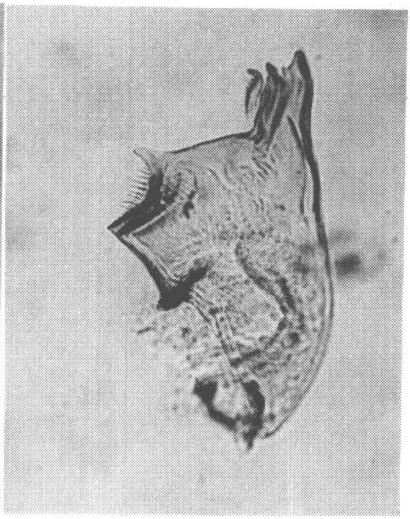


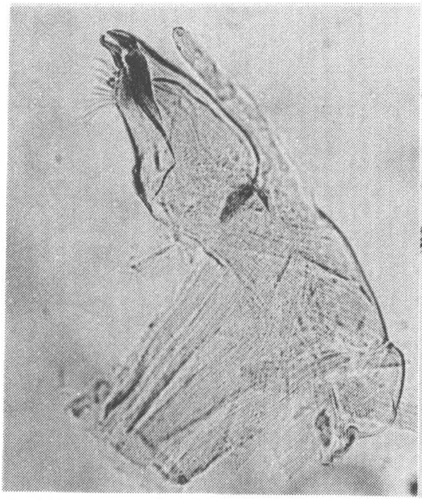
Fig. 10. Baetis sp. No. 1. A) nymph, B) claw, C) labium, D) abdominal gill, 2nd segment.



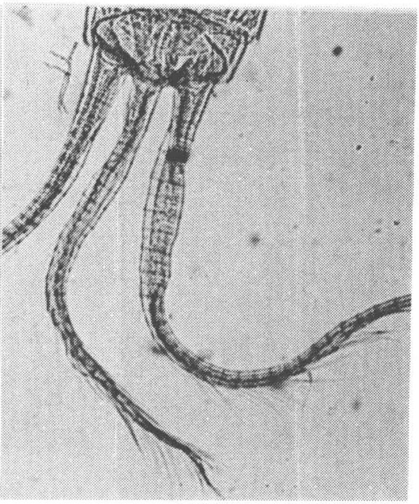
A



B



C



D

Fig. 11. Baetis sp. No. 1. A) right mandible, B) left mandible, C) maxilla, D) caudal filaments.

F

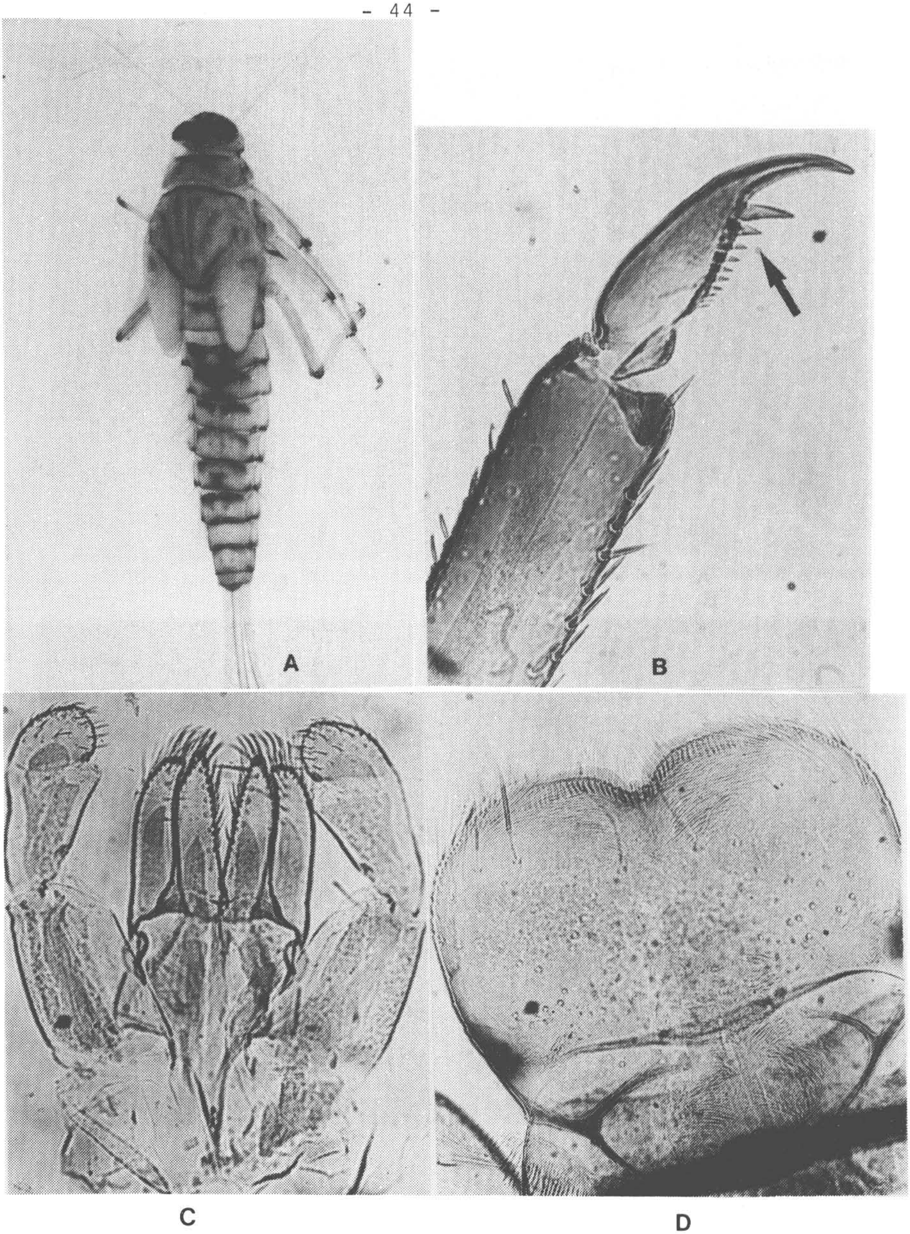


Fig. 12. Baetis sp. No. 2. A) nymph, B) claw Baetis No. 4, C) labium Baetis No. 4, D) labrum Baetis No. 4.

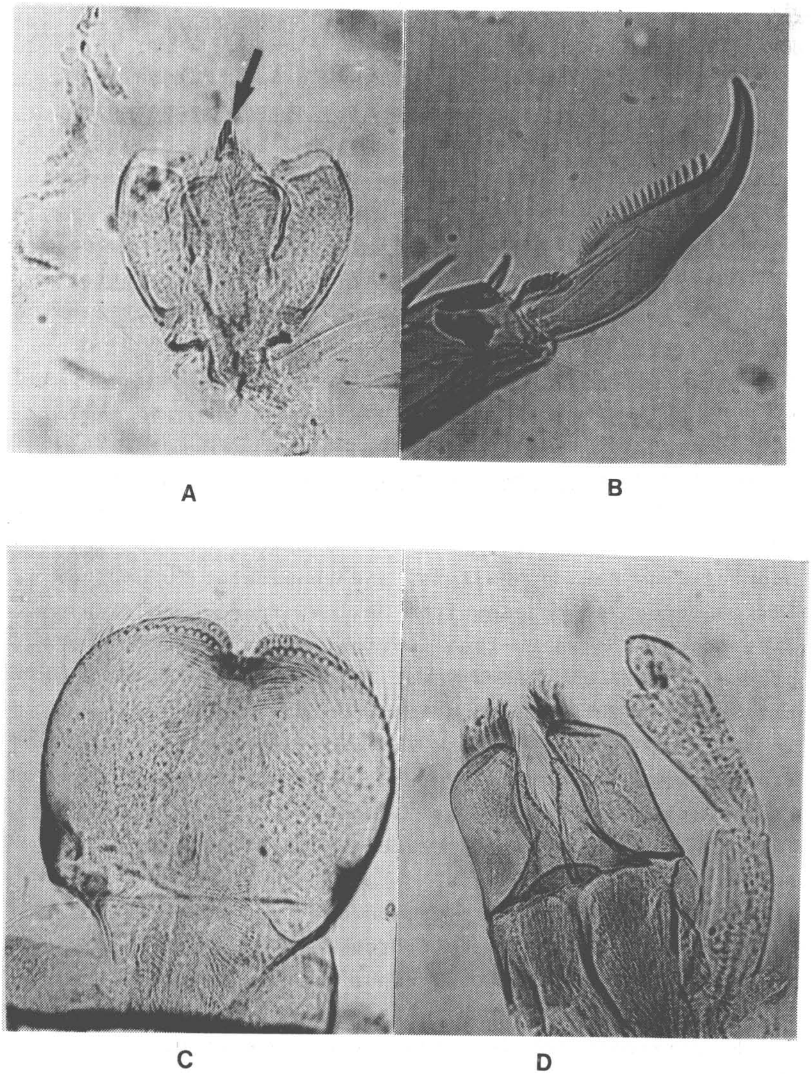


Fig. 13. Baetis sp. No. 3. A) hypopharynx, B) claw, C) labrum, D) labium.

Genus Baetodes NEEDHAM & MURPHY, 1924

This genus vas established by NEEDHAM & MURPHY in 1924. The type species was described as Baetodes serratus and the type locality was Tijuca, Rio de Janeiro, Brazil. The authors also reported in the same paper an unnamed species from Brazil as Baetodes nymph No.1. TRAVER (1943) described the species B. spiniferum from an adult specimen collected in Venezela. TRAVER (1944) reported B. serratus from Brazil. EDMUNDS (1950) summarizes the characteristics of the nymphal stages of the genus. DEMOULIN (1955) described B. itatiayanus from Brazil. PACKER (1966) reported an unnamed species from Honduras, and in the same year ROBACK reported another unnamed species from Peru. MAYO (1968) reported B. levis and B. spinae from Ecuador. COHEN & ALLEN (1972) described nine new species from Mexico and Central America. MAYO (1973) describes four new species from Mexico, Bolivia, and Venezuela. EDMUNDS et al. (1976) report 14 species from Mexico, from which five species occur also in Central America. COHEN & ALLEN (1978) present an illustrated key for 15 species in the nymphal stage, 13 of them reported from Central and South America; in the same paper B. velmae is described as a new species from Panama. Most of the known species of Baetodes have been identified from nymphal stages.
Table X shows the present status of this genus in Central and Northern South America.
The region in which Baetodes was best represented in this investigation was Rio Anori (Providencia). From this study it can be infered that this genus prefers warm, clear, and aireated water.
In the present study four species are reported.

Baetodes sp. No.1 (Fig. 14-15)
Material: 184 nymphs

Body lenth 4,0-5,0 mm; cerci 4,0-5,0 mm; general coloration pale-brown to dark-brown; mouth parts as in figures 14 and 15; claws with a prominent apical denticle, arising from its bases a long seta;coxal gills present. In general, all the characteristics of this species fit for B. proiectus (MAYO, 1973), but the body size is smaller and the number of claws denticles are more in the present species. From all Baetodes collected, 63.88% belong to this species, and from this percentage, 90.16% were found in Rio Anori (Providencia). The rest of the percentage (9.84%), was found in Rio Rionegro (El Tablazo). This means that this species may be regarded as indicator of clear water, but also tolerates a little pollution.

Figures 14 and 15 show some of the characteristics of this species.

Baetodes sp. No.2
Material: 56 nymphs

Body length 2,5-3,5mm; caudal filaments 3,0-4,0 mm; general coloration brown to dark-brown; claws with 6-7 denticles diminishing in size rearward; without coxal gills. The nearest species to which this specimen may belong is B. deficiens (COHEN&ALLEN, 1978), but the number of claws denticles and the absence of coxal gills may call for a new species description.

From the Baetodes collected, 19.44% belongs to this species, and from this percentage, 42.85% was found in Rio Anori (Providencia), 35.15% in Rio Rionegro (El Tablazo), and 22.0% in Quebrada La Agudelo. This means that this species may have a wide range of adaptation to different environments.

Baetodes sp. No.3
Material: 28 nymphs

Body length 3,0-4,0 mm; caudal filaments 3,0-4,0 mm; general coloration yellow-brown. This species is represented by 28 inmature nymphs and for this reason is difficult to set them in a correct classification.
From the Baetodes collected, 9.72% belongs to this species, and all of them were found in Rio Anori (Providencia).

Baetodes sp. No.4
Material: 20 nymphs

Body length 4,0 mm; caudal filaments broken; general coloration dark-brown; coxal gills present: abdominal tubercles barely discernible. The closest species to which this specimen may belong is B. obesus (COHEN & ALLEN, 1978) but the coloration pattern on the abdomen is different. In this species it is unicolor.
From the Baetodes collected, 6,96% belong to this species and it was found in Rio Anori (Providencia).

TABLE X: Species of the genus Baetodes, NEEDHAM & MURPHY, reported in Central and Northern South America

SPECIES	COUNTRY Br	Ec	Gu	Ho	Me	Bo	Pa	Pe	Ve	Sa
B.adustus, COHEN & ALLEN					X		X			
B.bellus, MAYO					X					
B.caritus, COHEN & ALLEN			X	X	X					X
B.andamagensis, MAYO								X		
B.chilloni, MAYO								X		
B.deficiens, COHEN & ALLEN				X	X					
B.fortinensis, MAYO					X					
B.furvus, MAYO					X					
B.fuscipes, COHEN & ALLEN				X	X					
B.inermis, COHEN & ALLEN					X					
B.itatiayanus, DEMOULIN	X									
B.levis, MAYO		X								
B.longus, MAYO					X					
B.noventus, COHEN & ALLEN			X	X						X
B.obesus, MAYO					X					
B.pallidus, COHEN & ALLEN				X	X					
B.pictus, COHEN & ALLEN					X					
B.peniculus, MAYO									X	
B.proiectus, MAYO						X				
B.sancticatarinae, MAYO	X									
B.soles, MAYO								X		
B.serratus, NEEDHAM & MURPHY	X									
B.spinae, MAYO		X								
x B.spiniferum, TRAVER									X	
B.traverae, MAYO								X		
B.tritus, COHEN & ALLEN			X	X	X		X			
B.velmae, COHEN & ALLEN							X			
B.veracrusensis, MAYO					X					
Baetodes nymph, No. 1 NEEDHAM & MURPHY, 1924	X									
Baetodes sp, PACKER, 1966				X						
Baetodes sp 1 to 5 ROBACK, 1966								X		

TABLE X (Continued):

(1) Br = Brazil
Ec = Ecuador
Gu = Guatemala
Ho = Honduras
Me = Mexico
Bo = Bolivia
Pa = Panama
Pe = Peru
Ve = Venezuela
Sa = El Salvador

x Species described from adults.

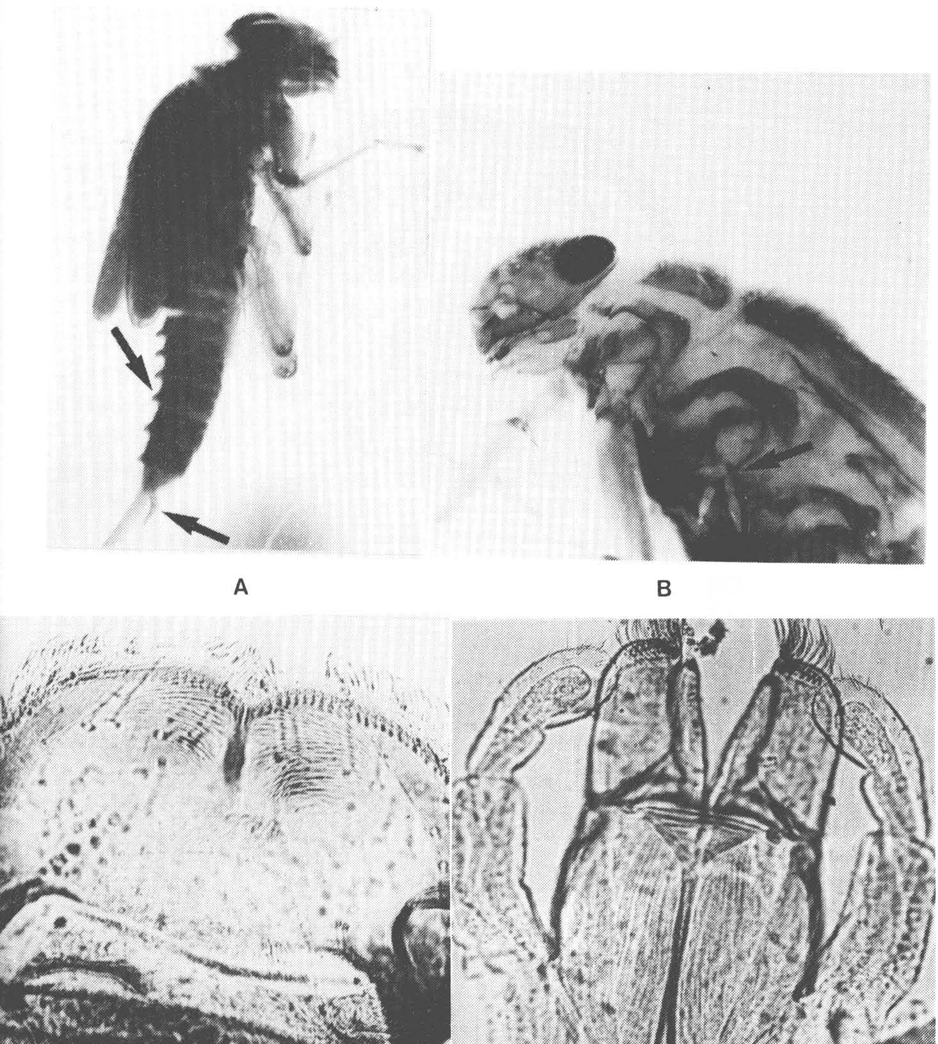
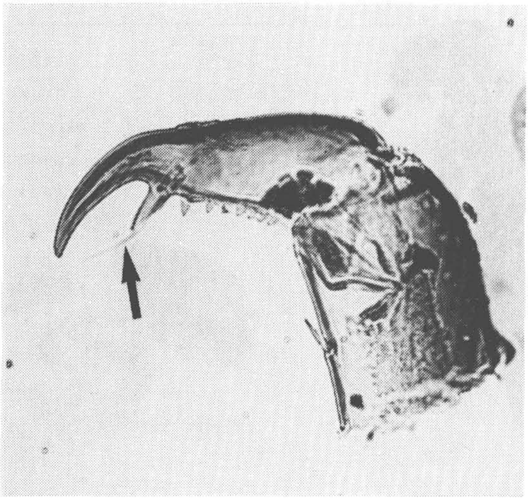
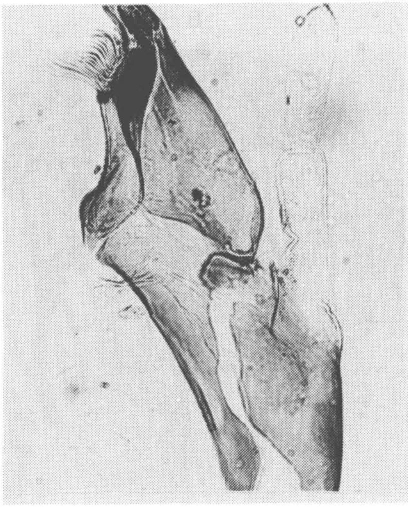


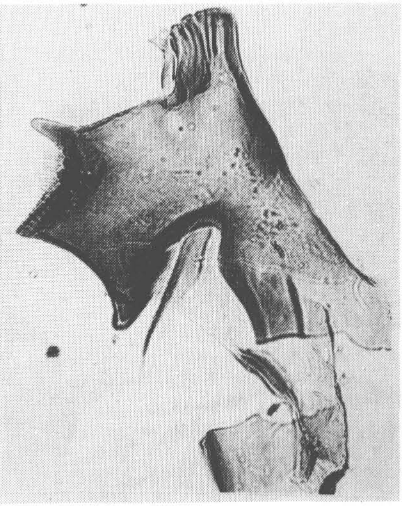
Fig. 14. Baetodes sp. No. 1. A) nymph, B) nymph showing coxal gills, C) labrum, D) labium.



A



B



C

Fig. 15. Baetodes sp.No. 1. A) claw, B) maxilla, C) left mandible.

Genus Dactylobaetis TRAVER & EDMUNDS, 1968

This genus was described for the first time by TRAVER (1944) as Baetinae No.1 from a nymph collected in the Mogi-Guaçu River, Brazil. She described it as an unknown genus characterized by "a claw very peculiar; appears flatened and truncate at tip, shaped like tip of a spatula, this truncate portion set with fine spines. (Claws of most mayfly nymphs are sharp pointed at tip)".
EDMUNDS & MUSSER (1960) reported as Baetis sp. nymphs "of an apparently undescribed species, having peculiar flattened claws with a truncate comb-like distal margin". It is clear that these authors refered to the genus that later was named Dactylobaetis. ILLIES (1964) also reported a nymph collected in the Rio Huallaga at Tingo Maria, Peru, as an "unknown Baetid genus, with extremely strong broad claws, which are effective organs of retention".
PACKKER (1966) reported another nymph of Dactylobaetis from Honduras and ROBACK (1966) also reported a nymph with spatulate claws from Rondos and Huallaga rivers, Peru, as "genus nr. Baetis sp." The genus was finally described as Dactylobaetis by TRAVER & EDMUNDS (1968); the type species was D. warreni; the type locality is Tuolumne River, Stanislaus County, California. Table XI shows the species which have been reported from Central and Northern South America.
In the present study only one species of Dactylobaetis is reported.

Dactylobaetis sp. nymph (Fig. 16-17)
Material: 200 nymphs
Body length 5,0-6,0 mm; caudal filaments 2,0-3.0 mm; general coloration yellow-brown; large hind wing pads.
All the individuals collected in the present study apparently belong to D. musseri. This species fits in general

into the key given by TRAVER & EDMUNDS (1968), but the number of denticles of claws could be ca. 37-40. The claws have also a triangular brown spot which is not reported for D. musseri. Figures 16 and 17 show some of the most important characteristics of this species.
According to TRAVER & EDMUNDS (1968), nymphs live in rocky streams, usually somewhat silty, at least during part of the year. From the Dactylobaetis collected, 64.0% were found in Rio Rionegro (El Tablazo) which remains silty most of the year due to the heavy rains and the erosion in the region; 6.0% was found in Rio Medellin (Primavera) which also remains silty most of the year due to heavy rainfall and sand extraction from its river bed; the remaining 30.0% were collected in Rio Anorí (Providencia) which stays clear most of the year. Thus it seems that this species shows a great adaptability to different environments, and may be regarded as indicator of predominant silty conditions in a river.

TABLE XI: Species of Dactylobaetis, TRAVER & EDMUNDS, reported from Central and Northern South America

SPECIES	COUNTRY (1)							
	Br	CR	ElS	Gu	Ho	Me	Pa	Pe
D. anubis, TRAVER & EDMUNDS	X							
D. arriaga, TRAVER & EDMUNDS						X		
D. cayumba, TRAVER & EDMUNDS								X
D. chiapas, TRAVER & EDMUNDS						X		
D. jensensi, TRAVER & EDMUNDS						X		
D. mexicanus, TRAVER & EDMUNDS						X		
D. musseri, TRAVER & EDMUNDS		X	X	X	X	X		
D. phedrus, TRAVER & EDMUNDS	X							
D. serapis, TRAVER & EDMUNDS	X							
D. zenobia, TRAVER & EDMUNDS				X?	X	X?	X?	
Dactylobaetis sp. A TRAVER & EDMUNDS, 1968						X		
Dactylobaetis sp. B TRAVER & EDMUNDS, 1968						X		
Dactylobaetis sp ILLIES, 1964								X

(1)Br = Brazil, CR = Costa Rica, ElS = El Salvador, Gu = Guatemala, Ho = Honduras, Me = Mexico, Pa = Panama, Pe = Peru.

X? means that these are species which bear some resemblance to D. zenobia, but differs from it in any other aspect.

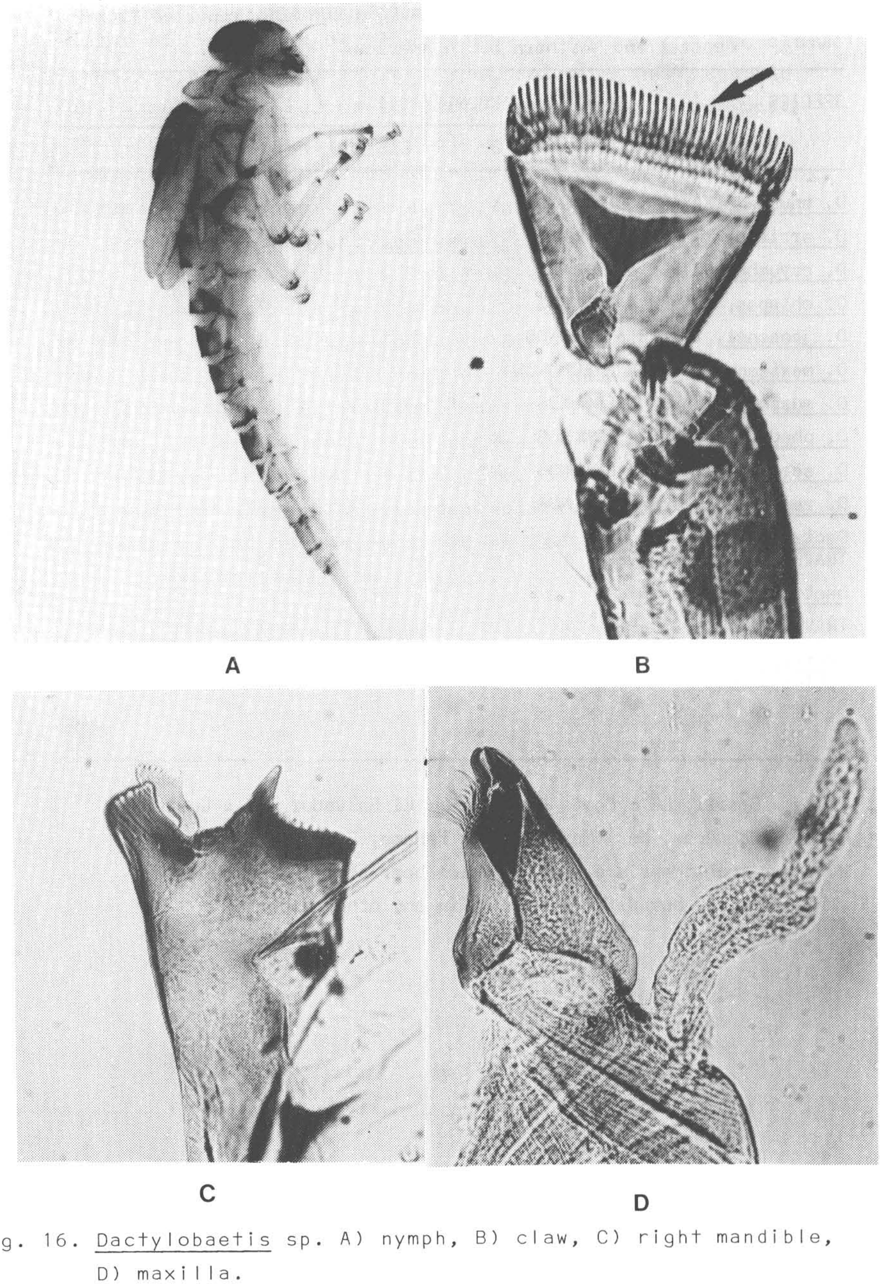
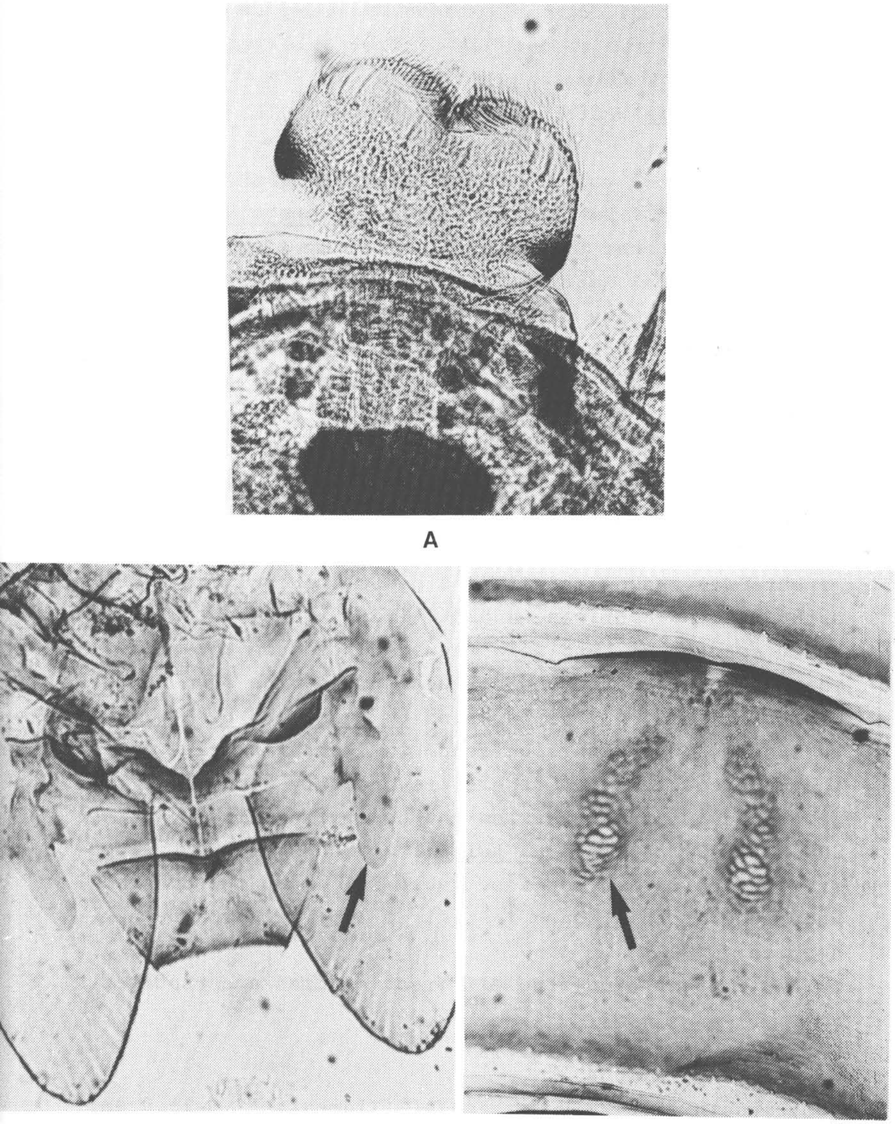


Fig. 16. Dactylobaetis sp. A) nymph, B) claw, C) right mandible, D) maxilla.



A

B

C

g. 17. <u>Dactylobaetis</u> sp. A) labrum, B) thorax with front wing pads and hind wing pads visible beneath, C) muscle insertion points in abdominal tergites.

FAMILY OLIGONEURIIDAE

Genus Lachlania HAGEN, 1868

The type species was described by HAGEN (1868) from six female imagos from Cuba as Lachlania abnormis. EATON (1833-88) reported L. lucida as a new species from Guatemala and Central America. NEEDHAM & MURPHY (1924) reported "several nymphs of this genus" collected in Guatemala as L. lucida, since by that time this species was "the only one yet known from Guatemala". ULMER (1943) give information about L. garciai from Ecuador and Bolivia, L. fusca from Costa Rica, and L. pallipes from Ecuador. TRAVER (1944) presents a key for the mayfly nymphs known to occur near Brazil; Lachlania is included in this key. EDMUNDS (1961) gives a key for the known nymphs of Oligoneuriidae and he reports the genus Lachlania as wide spread in the Americas. ROBACK (1966) reported two unnamed species of Lachlania from Peru, and in the same year PACKER reported another unnamed species from Honduras. EDMUNDS et al., (1976) reported L. fusca and L. lucida as species of common occurrence in Central America and they stated also that "there are probably a number of undescribed species in Mexico and Central America". ALLEN & COHEN (1977) reported L. talea from Honduras and L. iops from Mexico as new species. Table XII shows the present knowledge of this genus in Central and Northern South America.
In the present study two different species are reported.

Lachlania sp. No.1 (Fig. 18)
Material: 10 nymphs
Body length 15,0-22,0 mm; caudal filaments 12,0-15.0 mm; general coloration yellow-brown to dark-brown; claws with four denticles, the first one larger and stout; postero-

lateral projections of abdomen with small hairs and small spines. The most closely related species may be L. powelli EDMUNDS, but it differs by larger body size and the relation of femur-tibia which is about 1:1. In L. powelli tibia is shorter than the femur. Figure 18 shows the main characteristics of species No.1.
From the Lachlania collected, 60.0% were found in Quebrada La Agudelo which means that this species prefers to live in cold clear water.

Lachlania sp. No.2 (Fig. 19)
Material: 6 nymphs
Body length 10,0-12,0 mm; caudal filaments 6,0-7,0 mm; general coloration brown to yellow-brown; claws with 2-4 denticles, the first one larger; posterolateral abdominal projections with few very fine bristles and large spines (larger than L. powelli); abdominal terga 2-9 each with a distinct middorsal tubercle, tergum 1 with a small tubercle W-shaped. The most closely related species may be L. dencyanna. According to KOSS & EDMUNDS (1970) the presence of the abdominal tubercles is the only one characteristic that distinguishes L. dencyanna from the other known nymphs of Lachlania (Fig. 19). The main difference is the body size. At present no reports appear in the literature for L. powelli and L. dencyanna in the Neotropics. Figure 19 shows some of the most important characteristics of this species.
From the Lachlania collected, 40.0% were found in Quebrada la Agudelo, like species No.1.

TABLE XII: Species of Lachlania HAGEN reported in Central and Northern South America.

SPECIES	(1) COUNTRY							
	Br	Bo	Cr	Ec	Gu	Ho	Me	Pe
x L. fusca, NAVAS			X					
x L. garciai, NAVAS		X						
L. iops, ALLEN & COHEN							X	
L. lucida, EATON					X			
x L. pallipes, EATON				X				
x L. radai, NAVAS								X
L. talea, ALLEN & COHEN						X		
Lachlania sp. TRAVER, 1944	X							
Lachlania sp. PACKER, 1966						X		
Lachlania sp. 1, 2 ROBACK, 1966								X

(1) Br = Brazil, Bo = Bolivia, CR = Costa Rica, Ec = Ecuador, Gu = Guatemala, Ho = Honduras, Me = Mexico, Pe = Peru

x Species described from adults

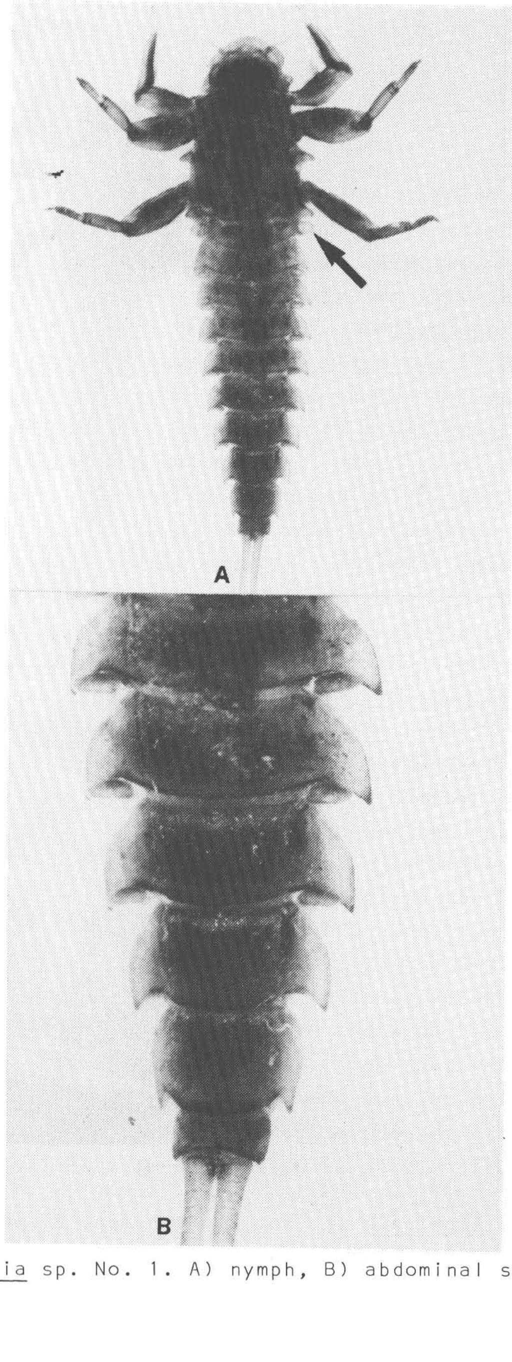


Fig. 18. Lachlania sp. No. 1. A) nymph, B) abdominal segments 5-10.

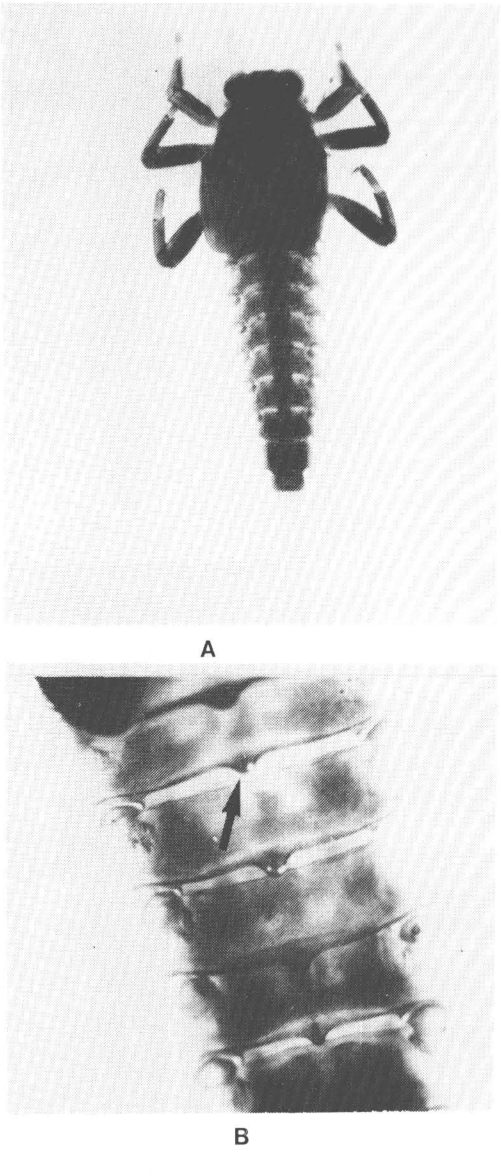


Fig. 19. Lachlania sp. No. 2. A) nymph, B) abdomen showing dorsal tubercles.

FAMILY LEPTOPHLEBIIDAE

Genus *Thraulodes* ULMER, 1920b

This genus was reported for the first time by EATON in 1853 as *Ephemera colombiae* WALKER, since the specimen was described from a single female subimago collected in Colombia. Since this time this genus has received different names: *Palingena colombiae* HAGEN, 1861 :304; *Leptophlebia colombiae* EATON 1871:84; *Adenophlebia colombiae* EATON 1881: 194; *Thraulodes colombiae* EATON 1884:110. Finally the genus was established by ULMER based on a male imago of *Thraulodes laetus* (EATON, 1883) from Colombia.
ULMER (1920b) described the type species as *Thraulodes laetus*. The type locality was New Granada, Colombia (sic.). *T. laetus* is the only mayfly species whose type locality is Colombia. NEEDHAM & MURPHY (1924) described for the first time the nymphal stage of this genus as *Thraulodes* sp. based on two specimens collected in Peru. ULMER (1943) described four new species: *T. lepida* (*T. lepidus* EDMUNDS et al., 1976), *T. venezuelana*, *T. bomplandi*, and *T. valens* from Colombia and South America. TRAVER (1944) described two species as *Thraulodes* A and B from two nymphs collected in Brazil. DEMOULIN (1955) described another species as *Thraulodes* sp. from a nymph collected also in Brazil. THEW (1960) described two new species: *T. daidaleus* and *T. traverae* from Brazil. ILLIES (1964) reported also *Thraulodes* sp. as a new species that occurs as well in the Andes and Brazilian mountains as in the Amazon lowland. ROBACK (1966) reported six unnamed species from Peru and also PACKER (1966) reported another *Thraulodes* sp. from Honduras.
TRAVER & EDMUNDS (1967) described 11 new species based both in nymphs and adults collected in Mexico, Honduras, Panama, Colombia, Ecuador, Peru, and Brazil. The species from Co-

lombia T. papilionis was collected in Tolima, 18 miles west from Honda. TRAVER & EDMUNDS (1967) reported also two unnamed species of Thraulodes from Mexico, three from Peru, and three from Colombia. Of the species from Colombia one was collected in Caqueza (Cundinamarca) and two in Villavicencio (Meta).

The most recent work carried out on this genus is presented by ALLEN & BRUSCA (1978). They reported 26 North and Central American species from which 21 are reported from Central America. For 11 of these species the nymphal stage is unknown. Table XIII shows a summary of the present knowledge of this genus in Central and Northern South America.

According to the key given by ALLEN & BRUSCA (1978) all the Thraulodes species dealt with in the present study belong to the gonzalesi-group. In this group there are five different species which fit only partially in the ALLEN & BRUSCA'S key.

Thraulodes sp. No.1 (Fig. 20-21)
Material: 96 nymphs

Body length 9-10 mm; caudal filaments 10-12 mm; general color dark-brown with dark transverse markings in the abdominal tergites; mesonotum with an U-shaped line; gills narrow, tapering gradually, without lateral trachea; claws with 6-7 large apical denticles, decreasing gradually in size and 6-8 small basal denticles. The nearest species to which this specimen bay belong is T. gonzalesi, but it differs in shape, size, and distribution of the claws denticles. Figures 20 and 21 show the most important characteristics of this species.

From all Thraulodes collected, 36.92% belongs to this species; and from this percentage, 63.3% were found in Rio Anori (Providencia), and 16.7% in Quebrada La Agudelo (El Retiro), both of clear and unpolluted water. The rest of this species, 20.0% were found in Rio Rionegro (El Tablazo), a moderately polluted water. This means that Thraulodes has a wide range of distribution as well in the cold water rivers in the mountains as in the warmer waters in the tropical rain forest.

Thraulodes sp. No.2 (Fig. 20 D)
Material: 72 nymphs
Body length 6-7 mm; caudal filaments 7-8 mm; general coloration light-brown, with dark-brown markings in abdominal segments 7 and 8; pronotum dark-brown; legs pale; femur with spines and very fine bristles tibia with a dense row of fine bristles; claws with 7-8 large denticles, the first one larger than the others and 6-8 small basal denticles; several dark spots on thorax and near lateral margin of abdomen; tails and caudal filaments with brown annulations diminishing rearward.
The closest species to which this specimen may belong is T. packeri, but the body size is bigger and the size and distribution of the claw denticles is also different.
From the Thraulodes collected, 27.7% belong to this species and from this percentage, 78.9% were found in Rio Anori (Providencia) and 21.1% in Quebrada La Agudelo (El Retiro), both of clear and unpolluted waters.

Thraulodes sp. No.3
Material: 68 nymphs
This species is similar to Thraulodes sp. No.2, but the body size is bigger (one specimen measured 11 mm), and this species lacks also dark spots on dorsal surface of abdomen.
From the Thraulodes collected, 26.15% belong to this species, and from this percentage 50.0% were found in Rio Anori (Providencia) and 20.0% in Quebrada La Agudelo; 30.0% were found in Rio Rionegro (El Tablazo). This means that this species has also a wide range of distribution and can also tolerate moderately polluted water.

Thraulodes sp. No.4
Material: 20 nymphs

Body length 11-12 mm; caudal filaments 9-10 mm. In general, this species fits into the description of the ALLEN & BRUSCA'S key (1978) for Thraulodes sp. B, but the abdominal gills are much more slender.
From the Thraulodes collected, 7.7% belong to this species, and from this percentage 75.0% were found in Q. La Agudelo and 25% in Rio Anori (Providencia). According to this result this species may regarded as indicator of water quality.

Thraulodes sp. No.5
Material: 4 nymphs

Body length 9 mm; caudal filaments broken. This species is represented only by four mature nymphs, whose main characteristic is a very dark-brown coloration through the body; legs light-brown with a large dark spot on the femur; gills slend; tarsal claws with 6 teeth all of them about the same size. This species was found in the Rio Anori (Providencia).

TABLE XIII: Species of the genus Thraulodes ULMER reported in Central and Northern South America.

SPECIES	(1) COUNTRY										
	Br	Co	CR	Ec	Gu	Ho	Me	Pa	Pe	Su	Ve
T.colombiae, WALKER		X									
T.bomplandi, ESB-PET	X										
T.centralis, TRAVER			X								
T.daidaleus, THEW	X										
T.ehrhardti, ULMER	X										
T.ephippiatus, TRAVER & EDMUNDS							X				
T.flavopedes, SPIETH										X	
T.gonzalesi, TRAVER & EDMUNDS							X				
T. hilaris, EATON			X?								
T.hilaroides, TRAVER			X								
T.humeralis, NAVAS							X				
T.irretitus, NAVAS			X								
T.itatiajanus, TRAVER & EDMUNDS	X										
T.laetus, NEED & MURPHY		X									
T.lepidus, EATON			X								
T.lunatus, TRAVERS & EDMUNDS							X				
T.maculipennis, ULMER	X										
T.mexicanus, EATON							X				
T.osiris, TRAVER & EDMUNDS				X							
T.packeri, TRAVER & EDMUNDS						X	X				
T.papilionis, TRAVER & EDMUNDS		X									
T.pedregoso, TRAVER			X								
T.plicatus, NEED & MURPHY									X		
T.prolongatus, TRAVER			X								
T.regulus, TRAVER & EDMUNDS									X		
T.schlingeri, TRAVER & EDMUNDS									X		
T.spangleri, TRAVER & EDMUNDS							X				
T.telegraphicus, NEED & MURPHY									X		
T.traverae, THEW	X										
T.trijunctus, BANKS									X		

TABLE XIII (Continued):

	SPECIES	Country										
		Br	Co	CR	Ec	Gu	Ho	Me	Pa	Pe	Su	Ve
x	T.ulmeri, EDMUNDS	X										
x	T.valens, EATON			X					X			
x	T.venezuelana, ULMER											X
x	T.zonalis, TRAVER & EDMUNDS			X					X			
	Thraulodes sp., NEED & MURPHY,1924									X		
	Thraulodes sp. A TRAVER, 1944	X										
	Thraulodes sp. B TRAVER, 1944	X										
	Thraulodes sp. B, DEMOULIN, 1955	X										
	Thraulodes sp.1-6, ROBACK, 1966									X		
	Thraulodes sp. TRAVER & EDMUNDS, 1967		X					X		X		
	Thraulodes sp. A ALLEN & BRUSCA, 1978						X	X				
	Thraulodes sp. B ALLEN & BRUSCA, 1978							X				
	Thraulodes sp. C ALLEN & BRUSCA, 1978						X	X	X			
	Thraulodes sp. D ALLEN (BRUSCA, 1978						X	X				
	Thraulodes sp. E ALLEN & BRUSCA, 1978			X								
	Thraulodes sp. F ALLEN & BRUSCA, 1978					X		X				
	Thraulodes sp. G ALLEN & BRUSCA, 1978							X				

(1) Br = Brazil, Co = Colombia, CR = Costa Rica, Ec = Ecuador, Gu = Guatemala Ho = Honduras, Me = Mexico, Pa = Panama, Pe = Peru, Su = Surinam, Ve = Venezuela.

x Species described from adults

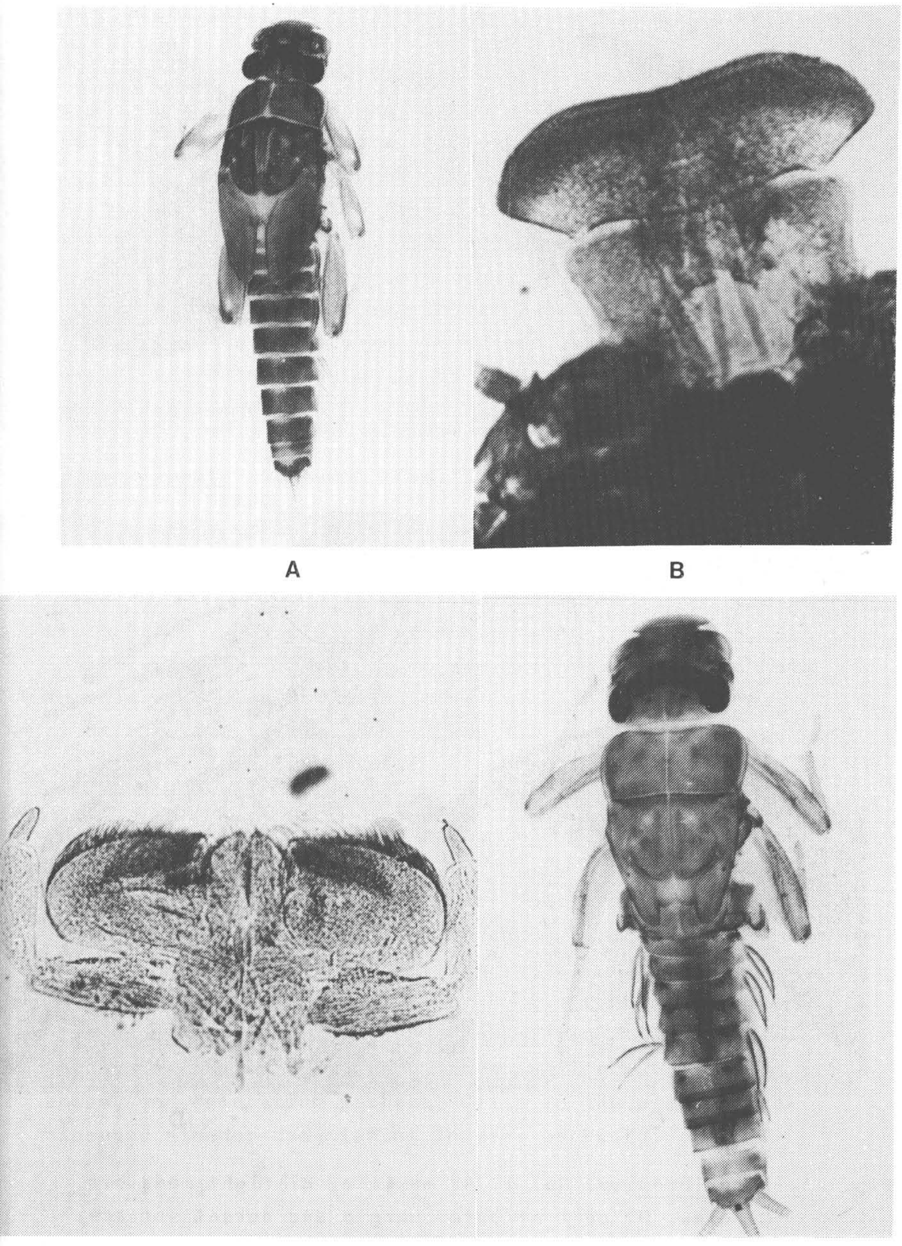


Fig. 20. Thraulodes sp. No. 1. A) nymph, B) labrum, C) labium, D) Thraulodes sp. No. 2.

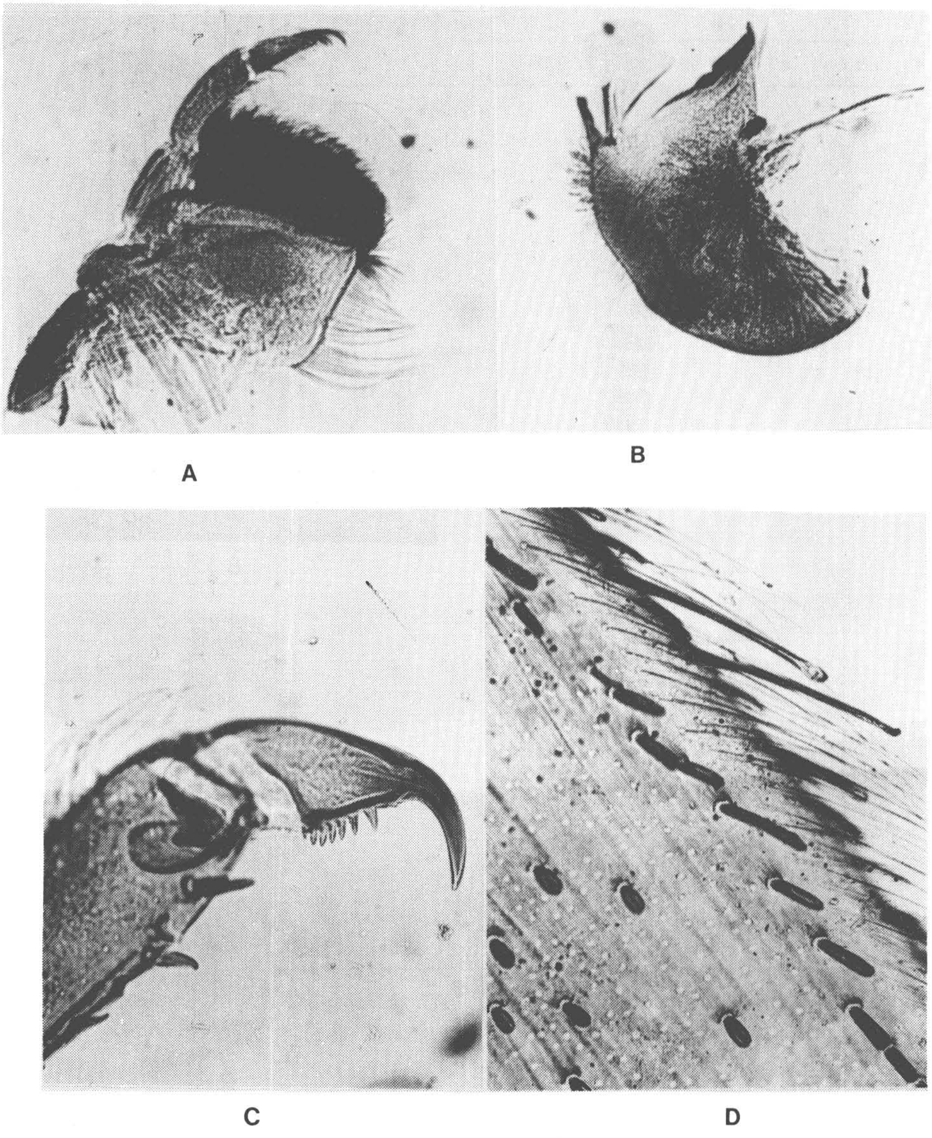


Fig. 21. Thraulodes sp. No. 1. A) maxilla, B) right mandible, C) claw, D) part of outer margin and dorsal surface of femur.

Genus Hermanellopsis DEMOULIN, 1955

The type species was described by SPIETH (1943) as Hermanella incertans from a male imago collected in Surinam. DEMOULIN (1955) reported from Brazil Hermanella sbg. Hermanellopsis sbg. nov. ROBACK (1966) reports also Hermanella (Hermanelopsis) DEMOULIN from Peru. EDMUNDS et al. (1976) report Hermanellopsis sp. from Panama, but they also stated that the "taxonomy of this genus is poorely known, and the identity of the species in Panama is in question " (Table XIV). In the present study one species only is reported, represented by a single nymph collected in Rio Anori (Providencia).

Hermanellopsis sp. nymph (Fig. 22-23)
Material: 1 nymph
Body length 7,0 mm; caudal filaments broken at tip, but the remainder part measured 4,0 mm; labrum about two times as wide as broad, with five denticles in the median emargination; maxille and mandible as in figure 22 A, B; labium with the third segment conical, and about the half in size of the second segment; claws with a large and stout apical denticle, and 12 smaller denticles diminishing in size backward; hind wings pads present; gills deeply forked, without tracheal branches; posterolateral spines present on abdominal segments 8 and 9; general coloration yellow-brown.
Comparing this genus with the one reported by DEMOULIN (1955) we can see two main differences: the labrum in the DEMOULIN'S species is larger, and the labial and maxillary palpus have much more setae than in the genus here reported. Compared with the one of ROBACK (1966) the main difference is in the gills which have a different size, shape, and coloration pattern. Gills in the present species are slender diminishing in size backward.

According to the previous differences this genus must be revised in detail. Figures 22-23 show some of the most important characteristics of this species.

TABLE XIV. Species of the genus *Hermanellopsis* DEMOULIN reported in Central and Northern South America.

Species	Country			
	Brazil	Panama	Peru	Surinam
H. incertans (SPIETH)				X
H. sbg. *Hermanellopsis* sbg. nov. DEMOULIN	X			
H. (Hermanellopsis) DEMOULIN (ROBACK, 1966)			X	
Hermanellopsis sp. (EDMUNDS et al., 1976)		X		

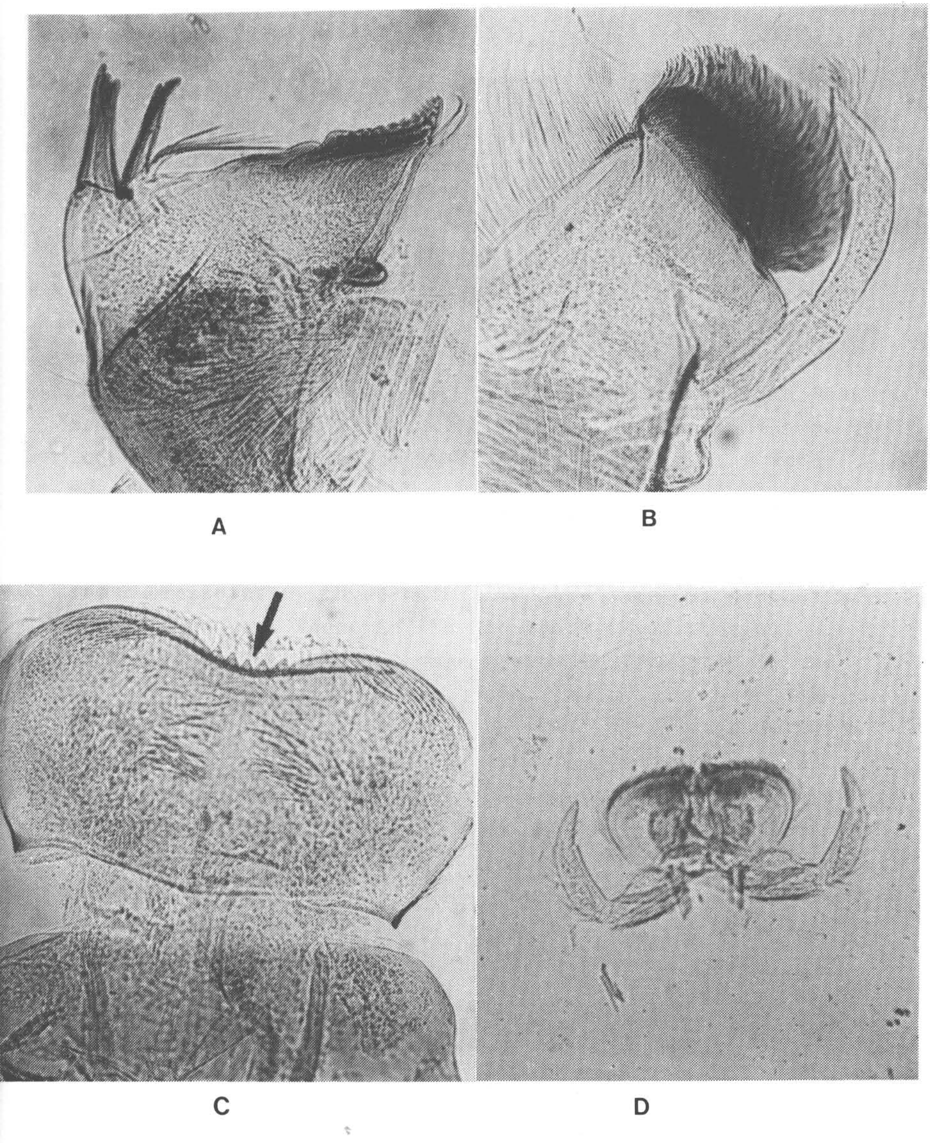
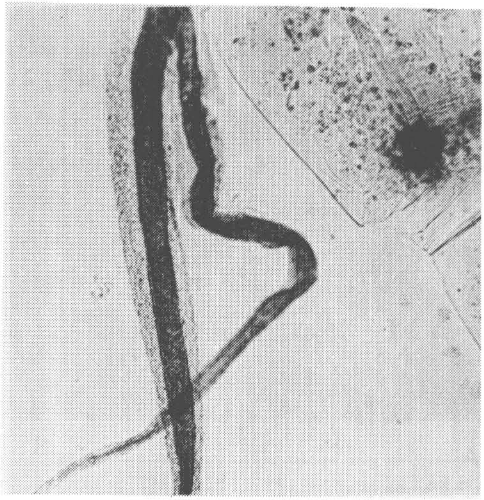
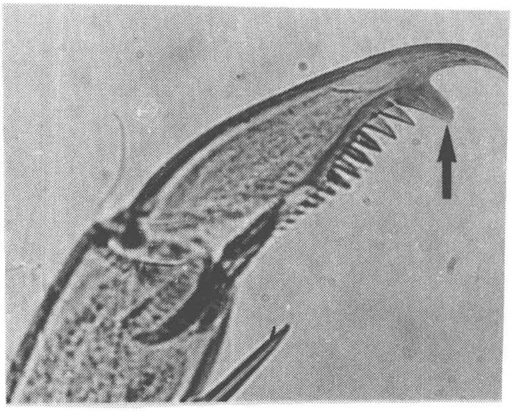


Fig. 22. Hermanellopsis sp. A) right mandible, B) maxilla, C) labrum , D) labium.



A



B

Fig. 23. <u>Hermanellopsis</u> sp. A) gill, 2nd segment, B) claw.

"Leptophlebiid" nymph (Fig. 24-25)
Material: 4 nymphs

Body length 6,0-7,0 mm; caudal filaments broken 1,5 mm from the base; labrum about twice as wide as long; medial emargination with six denticles; labium as in figure 24 C, notice specially the conical shape of the labial palpus and the row of setae and spines; maxilla and left mandible as in figure 25; claws with 10-11 denticles with a large and stout denticle in the middle; general coloration brown, with dark markings on abdominal segments 1-6; posterolateral abdominal projections yellow, 8 and 9 termining in long and sharp spines, abdominal segments 5 and 6 with less pronounced spines; gills bifid with dark tracheal branches; legs yellow with a dark spot near the middle of the femur; caudal filaments with dark transverse markings and a dense row of bristles along inner margin.

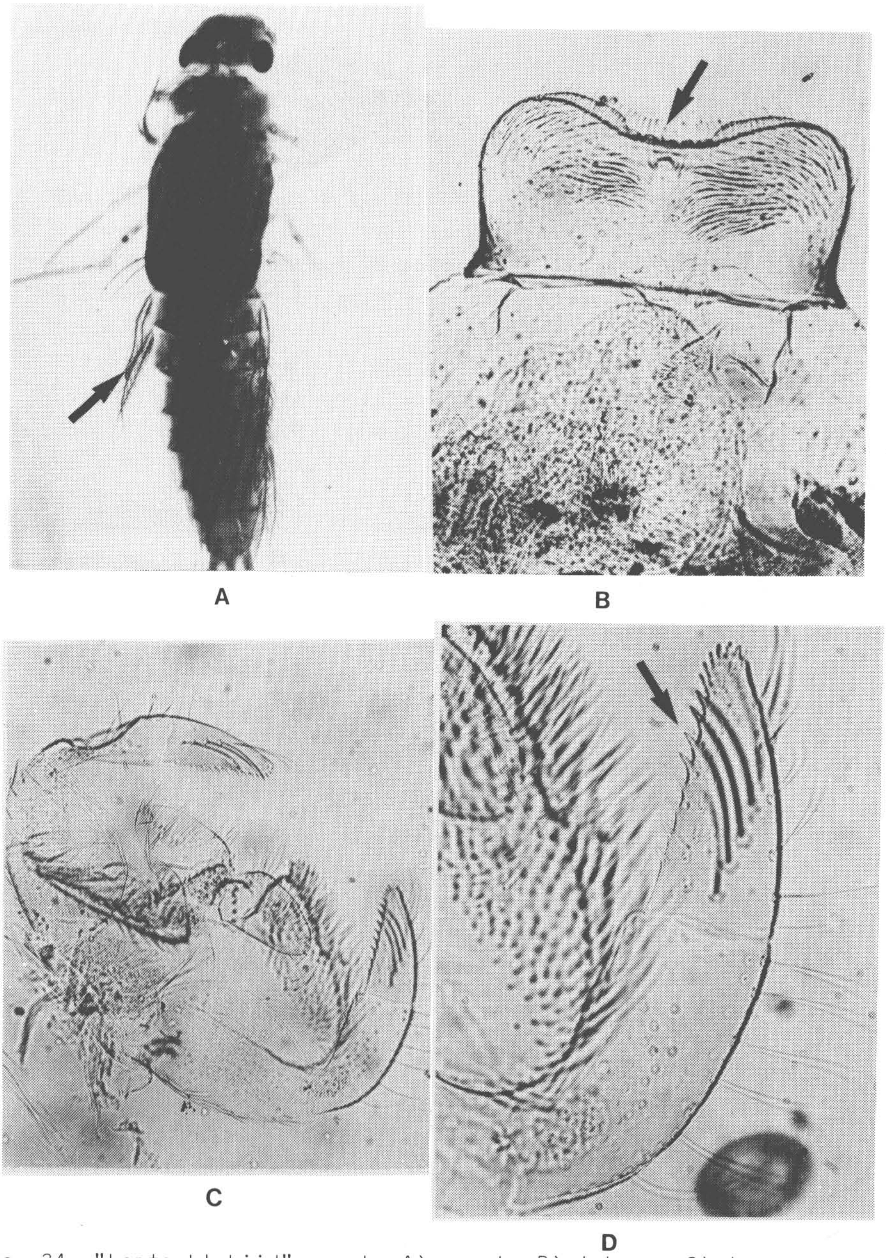
The "Leptophlebiid" nymphs collected in the present study are represented by three mature and one inmature nymphs; all of them were found in the Rio Anori (Providencia).

To the present knowledge, only two genera reported in the Neotropics have some similarities to the nymphs here described. The first is Adenophlebia EATON, reported by ROBACK (1966) from Peru. He reported four unnamed species. The nymphs here collected fit quite well into the descriptions for Adenophlebia sp.1 (ROBACK, 1966); but the distribution, size, and number of the denticles of the claws are different; the color pattern on dorsal surface of abdominal segments is also different. The second genus similar to the "Leptophlebiid" nymph herein reported is Terpides guayanensis DEMOULIN (1966) from Surinam. This genus has also a close resemblance to the nymphs here reported, and specially the claws are very similar.

According to the above mentioned situation these two genera need revision. The same genus will therefore not be described two times.

This group of "Leptophlebiid" nymphs of mayflies are one of the most poorely known in the Neotropics, and still a great deal of research has to be done before it will be possible to place them in a correct genus, and even more, to give a species name. Figures 24-25 show some of the most important characteristics of the "Leptophlebiid" nymphs herein reported.

All of these nymphs were collected in Rio Anori (Providencia).



ig. 24. "Leptophlebiid" nymph. A) nymph, B) labrum, C) labium, D) labial palpus.

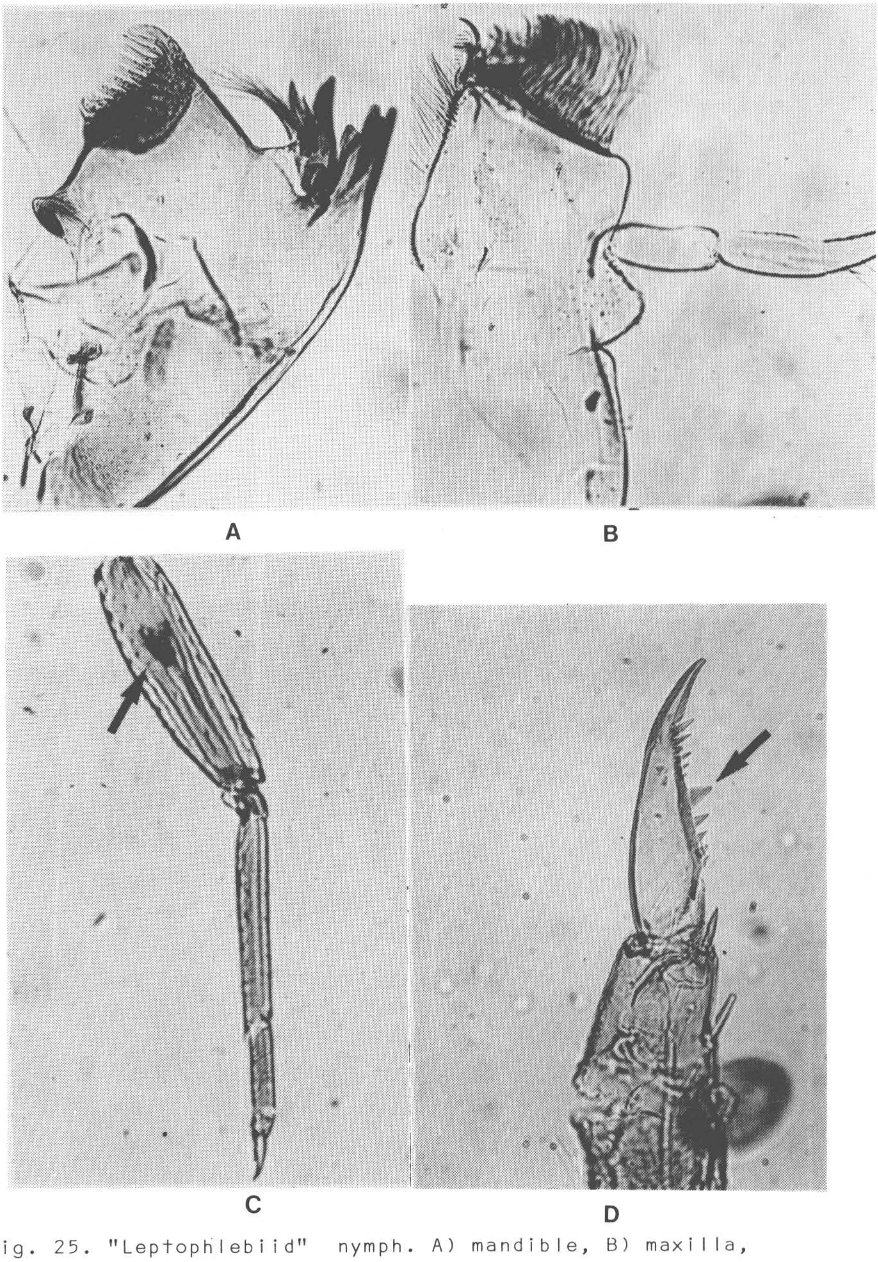


Fig. 25. "Leptophlebiid" nymph. A) mandible, B) maxilla, C) leg, D) claw.

FAMILY TRICORYTHIDAE

Genus Leptohyphes EATON, 1882

The genus Leptohyphes was set up by EATON in 1882 and the type species was described from an adult female as L. eximius; the type locality was Cordoba, Argentina. EATON (1892) reported L. brevissimus from Guatemala and ULMER (1919) L. costaricanus from Costa Rica. NEEDHAM & MURPHY (1924) reported L. mollipes from Brazil and two unnamed species as Leptohyphes No. 1 from Guatemala and Leptohyphes No. 2 from Peru; they also give a key for adult identification of six species. TRAVER (1944) reports two unnamed species as Leptohyphes A and B from Brazil. TRAVER (1958) reports three new species from Mexico and one from Costa Rica; the same author also reports in the same year L. mithras from Costa Rica and Honduras, but the last one was doubtful. ILLIES (1964) reports Leptohyphes from Peru. PACKER (1966) reports Leptohyphes sp. from Honduras, and ROBACK (1966) reports also six unnamed species from Peru. ALLEN (1967) describes 22 new species of Leptohyphes from which 18 are reported from Central and South America; from these species, nine are from Peru, four from Brazil, two from Panama, two from Guatemala, and one from Honduras. MAYO (1968) reports three new species from Ecuador. ALLEN & ROBACK (1969) described four new species from Peru and included redescriptions and notes for four more species, also from Peru. BRUSCA (1971) reports a new species from Mexico. ALLEN & BRUSCA (1973) described 10 new species of Leptohyphes, from which nine are from Mexico and one from Guatemala. ALLEN (1973) described five new species from Brazil and two from Peru. EDMUNDS et al. (1976) report a total of 29 species of Leptohyphes from North and Central America, from which 12 are reported from South Mexico, nine from Central

America, and one from both places.
Table XV shows the present status of this genus in Central and Northern South America.
Int the present study three different species were recognized.

Leptohyphes sp. No.1 (Fig. 26-27)
Material: 464 nymphs
Body length 4,0-5.0 mm; caudal filaments 3,5-4,5 mm; general color yellow with dark markings; legs with dark bands on femur, tibia, and tarsus; femora with spines arranged as in figure 26 B; claws with 3-4 denticles and two filaments at tip; abdominal segments with long spines along their bases; caudal filaments with spines each two segments; mouth parts as in figure 27; maxillary palpus 3-segmented; operculate gills yellow-brown. Figures 26 and 27 show the most important characteristics of this species.
From all *Leptohyphes* collected, 69.89% belong to this species, and from this percentage, 40.55% were found in Rio Anori (Providencia), 32.43% in Rio Rionegro (EL Tablazo), 24.32% in Rio Medellin (Primavera), and 2.7% in Quebrada La Agudelo. Accordingly this species shows the greatest adaptability to different environments. Species of the genera *Leptohyphes* and *Baetis* were the only ones that were found in all the stations studied.

Leptohyphes sp. No. 2
Material: 148 nymphs
This species is similar to species No.1, but the general color is dark-brown; furthermore there is a predominance of 5-6 tarsal denticles; in most specimens the femur presents a bigger size and more spines, but arranged in similar way.
From the *Leptohyphes* collected, 22.28% belongs to this species, and from this percentage, 51.35% was found in Rio Medellin (Primavera), 24.34% in Rio Anori (Providencia),

18.91% in Rio Rionegro (El Tablazo), and 5.4% in Quebrada La Agudelo (El Retiro). Like species No.1, species No.2 shows also a great adaptability to different environments, but in this case it was more abundant in Rio Medellin (Primavera).

Leptohyphes sp. No.3
Material: 52 nymphs
Similar to species No.1 and No.2, but the color is even more dark; body thicker; the middle lobes of labium smaller than in the mentioned species. From the Leptohyphes collected, 7.83% belongs to this species, and from this percentage, 69,23% was found in Rio Anori (Providencia), and 30,77% in Rio Rionegro (El Tablazo). In relation to the species of Leptohyphes previously cited this species shows less adaptability to different environments and prefers warm and clear water.
All three species here reported and the ones cited in the literature have the presence of denticles on inner margin of claws as a common characteristic. However, EDMUNDS et al. (1976) state that one of the nymphal characteristics of this genus is "claws without denticles". Thus, this concept has to be revised, otherwise it will cause even more confusion in this complex group.

TABLE XV. Species of the genus *Leptohyphes* EATON reported in Central and Northern South America.

Species	Country (1)								
	Br	CR	Ec	Gu	Ho	Me	Pa	Pe	ElS
L. albus MAYO			X						
L. alleni BRUSCA						X			
x*L. berneri* TRAVER						X			
L. asperulus ALLEN								X	
x*L. brevissimus* EATON				X					
L. brunneus ALLEN & BRUSCA						X			
L. costarricanus EATON		X							
L. carinus ALLEN								X	
L. castaneus ALLEN				X					
L. consortis ALLEN & BRUSCA						X			
L. comatus ALLEN								X	
L. cornutus ALLEN	X								
L. dicinctus ALLEN & BRUSCA						X			
L. echinatus ALLEN & ROBACK								X	
L. ecuador MAYO			X						
L. edmunsi ALLEN	X								
L. ferruginus ALLEN & BRUSCA						X			
L. gibbus ALLEN	X								
L. hirsutus ALLEN & ROBACK						X		X	
L. hispidus ALLEN & BRUSCA						X			X
L. illiesi ALLEN								X	

TABLE XV. Species of the genus *Leptohyphes* reported in Central and Northern South America. (Continued)

Species	(1) Country								
	Br	CR	Ec	Gu	Ho	Me	Pa	Pe	ElS
L. invictus ALLEN								X	
L. jodiannae ALLEN								X	
L. lestes ALLEN & BRUSCA						X			
L. lumas ALLEN & BRUSCA						X			
L. maculatus ALLEN								X	
L. melanobrancus ALLEN & BRUSCA				X					
x *L. mithras* TRAVER		X			X?				
L. minimus ALLEN	X								
x *L. molipes* NEEDHAM & MURPHY	X								
L. murdocki ALLEN							X		
L. musseri ALLEN				X	X				
L. myllonatus BRUSCA & ALLEN								X	
L. nanus ALLEN					X		X		
L. packeri ALLEN					X				
L. petersi ALLEN								X	
L. pilosus ALLEN & BRUSCA						X			
L. piraticus ALLEN					X				
L. blaumanni ALLEN	X								
x *L. priapus* TRAVER		X							
L. pupulus ALLEN	X								
L. rallus Allen								X	
x *L. sabinas* TRAVER					X	X			
L. setosus ALLEN								X	

TABLE XV. Species of the genus Leptohyphes EATON reported in Central and Northern South America (Continued)

Species	Country								
	Br	CR	Ec	Gu	Ho	Me	Pa	Pe	ElS
L. spiculatus ALLEN & BRUSCA						X			
L. spinosus ALLEN & ROBACK								X	
L. tacajalo MAYO			X						
L. tinctus ALLEN	X								
L. tuberculatus ALLEN								X	
L. undulatus ALLEN	X								
L. viriosus ALLEN	X								
L. vulturnus ALLEN					X				
x*L. zalope* TRAVER						X			
L. zelus ALLEN				X	X				
Leptohyphes No.1 (NEEDHAM & MURPHY, 1924)				X					
Leptohyphes No.2 (NEEDHAM & MURPHY, 1924)								X	
Leptohyphes sp. A and B (TRAVER, 1944)	X								
Leptohyphes sp. (ILLIES, 1964)								X	
Leptohyphes sp. 1 to 6 (ROBACK, 1966)								X	
Leptohyphes sp. (PACKER, 1966)					X				

(1) Br=Brazil, CR=Costa Rica, Ec=Ecuador, Gu=Guatemala, Ho=Honduras, Me=Mexico, Pa=Panama, Pe=Peru, ElS=El Salvador

x Species described from adults

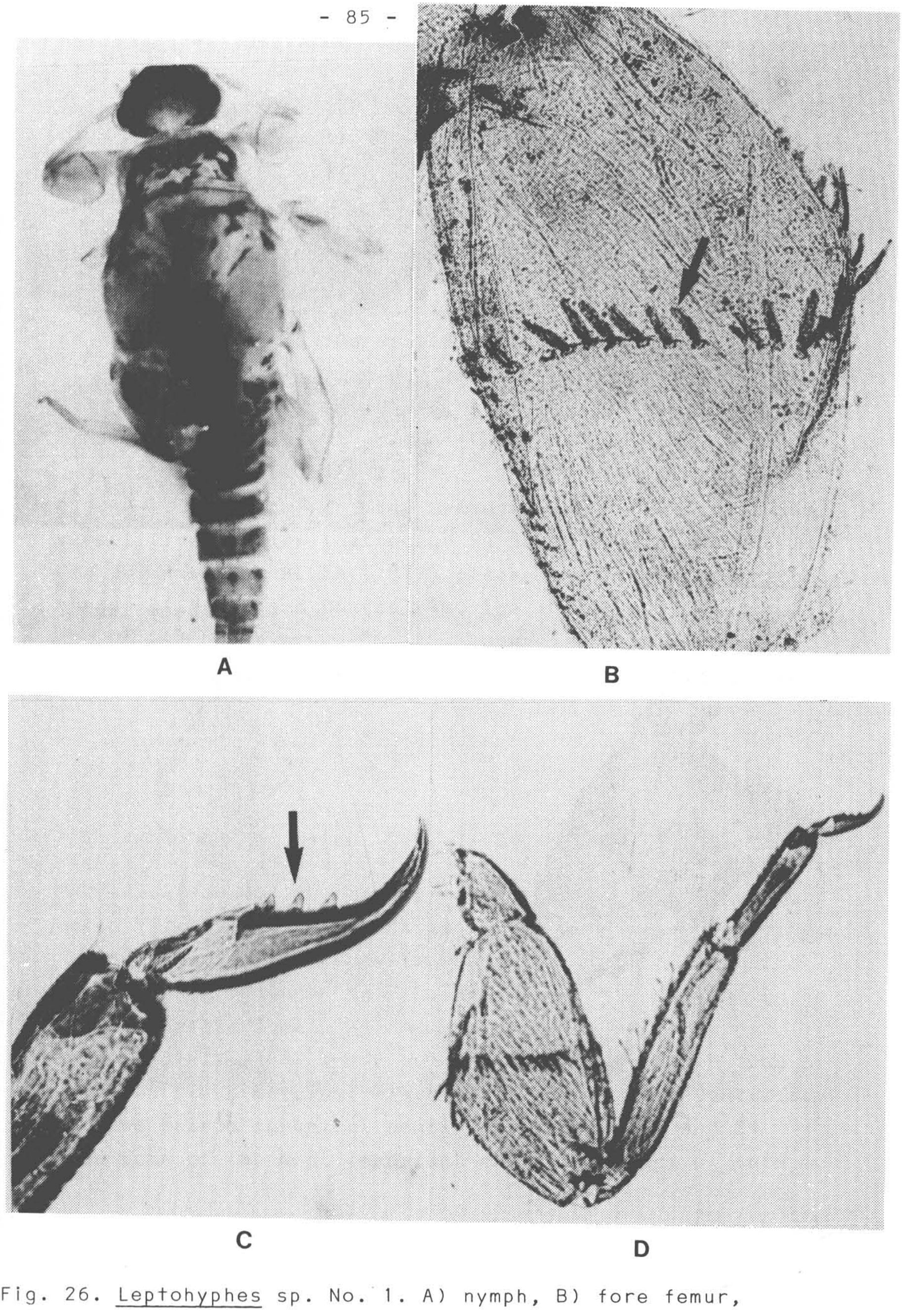


Fig. 26. <u>Leptohyphes</u> sp. No. 1. A) nymph, B) fore femur, C) claw, D) foreleg.

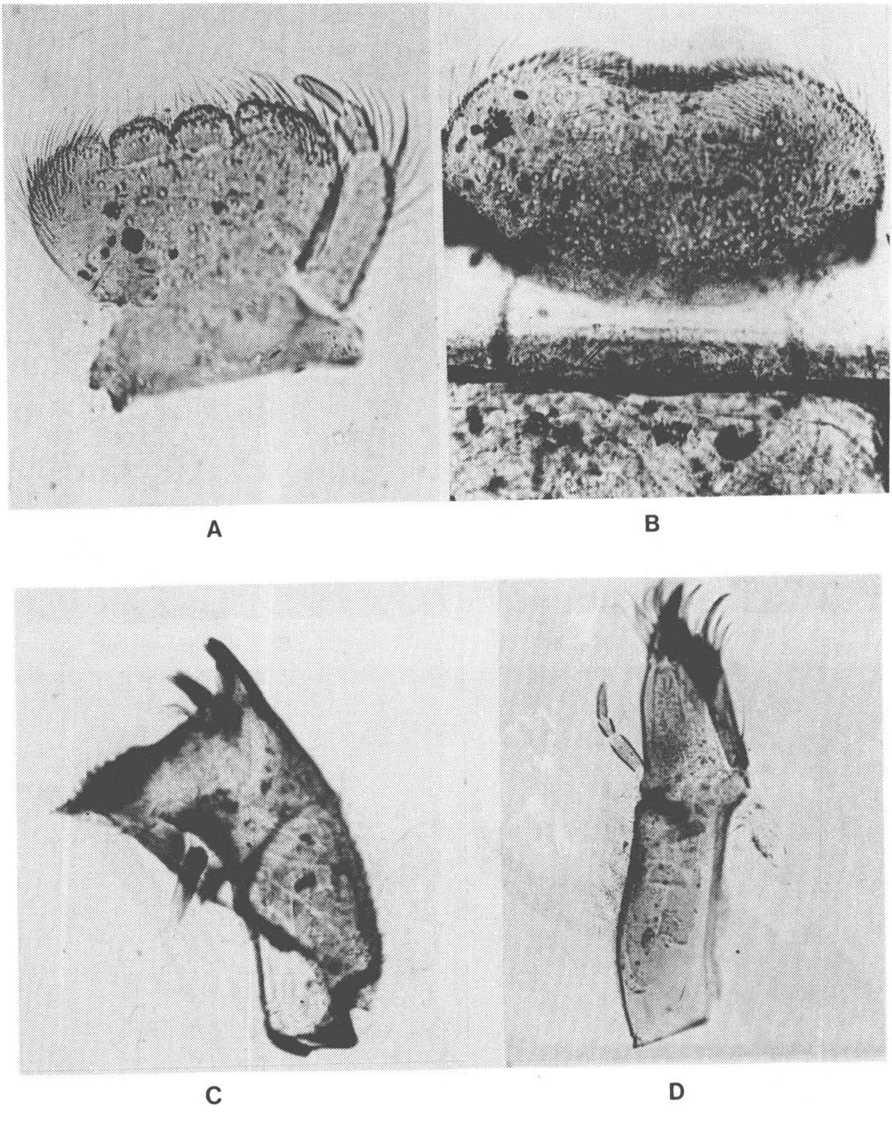


Fig. 27. Leptohyphes sp. No. 1. A) labium, B) labrum, C) right mandible, D) maxilla.

Genus Tricorythodes ULMER, 1920

This genus was reported for the first time by EATON in 1892 when he described T. explicatus (Sub nom. Tricorythus) from adults collected in Mexico. ULMER (1920) established the genus Tricorythodes from the type species T. explicatus (EATON). NEEDHAM & MURPHY (1924) report this genus known in Central and South America, from Guatemala to Argentina, but they do not mention specific countries in which it can be found. TRAVER (1958) describes T. australis from Brazil, and three more species from Mexico. ALLEN (1967) describes three new species of Tricorythodes from Brazil, one from Mexico, and one from Costa Rica. ALLEN & ROBACK (1969) described T. ocellus from Peru. ALLEN & BRUSCA (1973) reported two new species from Mexico. EDMUNDS et al. (1976) report five species that occur in South Mexico and one in Central America. ALLEN (1977) places the nymphs of Tricorithodes of North and Central America in two species-groups, the albilineatus-group and the curvatus-group. Table XVI shows the present status of this genus in Central and Northern South America.
In the present study only one species of this genus is reported.

Tricorythodes sp. nymph (Fig. 28-29)
Material: 96 nymphs
Body size 3.0-4,0 mm; caudal filaments 1,5-2,5 mm; general color yellow, with black markings on thorax; abdomen with transverse wide black bands from segments 1 to 6, and black dorsal spots on segments 7 to 9; mouth parts as in figures 28-29; maxillary palpi 1-segment and very short; operculate (Fig. 29 D) gill on segment 2 triangular with long bristles along margins; claws with 7-9 marginal denticles, and two paired subapical denticles. Figures 28 and 29 show some of the most important characteristics of this

species.
According to ALLEN (1977) this species may belong to the *albilineatus*-group, but the characteristics to distinguish nymphs of this group have not been described as yet. All the specimens collected are characterized also by having the body covered with fine grains of sand and many very fine bristles on legs and other parts of the body surface, where fine particles are gathered. Maybe this is related to the type of bottom and water. EDMUNDS et al. (1976) state that this species lives in silted waters. The present species was collected only in Rio Rionegro (El Tablazo), which remains silty most of the time all around the year. Thus this species may be regarded as an indicator of predominant silty conditions of a given river.

TABLE XVI. Species of the genus *Tricorythodes* ULMER reported in Central and Northern South America.

Species	Br	CR	Ho	Me	Pe	Sur
	(1) Country					
x*T. angulatus* TRAVER				X		
x*T. australis* (BANKS)	X					
T. barbus ALLEN	X					
T. bullus ALLEN	X					
x*T. comus* TRAVER				X		
T. cristatus ALLEN	X					
T. edmunsi ALLEN				X		
x*T. explicatus* EATON				X		
x*T. mulaiki* TRAVER				X		
T. notatus ALLEN & BRUSCA				X		
T. ocellus ALLEN					X	
T. sordidus Allen		X				
T. ulmeri ALLEN & BRUSCA				X		
Tricorythodes sp. (DEMOULIN, 1966)						X
Tricorythodes sp. (PACKER, 1966)			X			
Tricorythodes sp. (ROBACK, 1966)					X	

(1) Br=Brazil, CR=Costa Rica, Ho=Honduras, Me=Mexico, Pe=Peru, Sur=Surinam.

x Species described from adults.

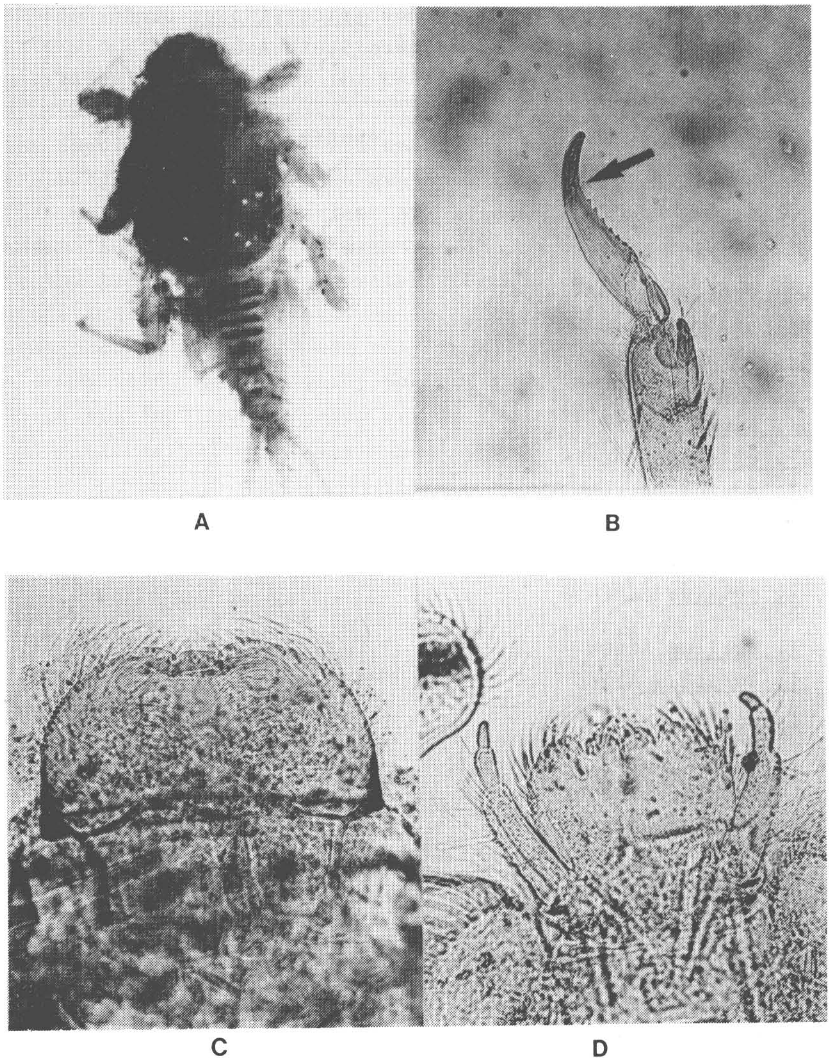
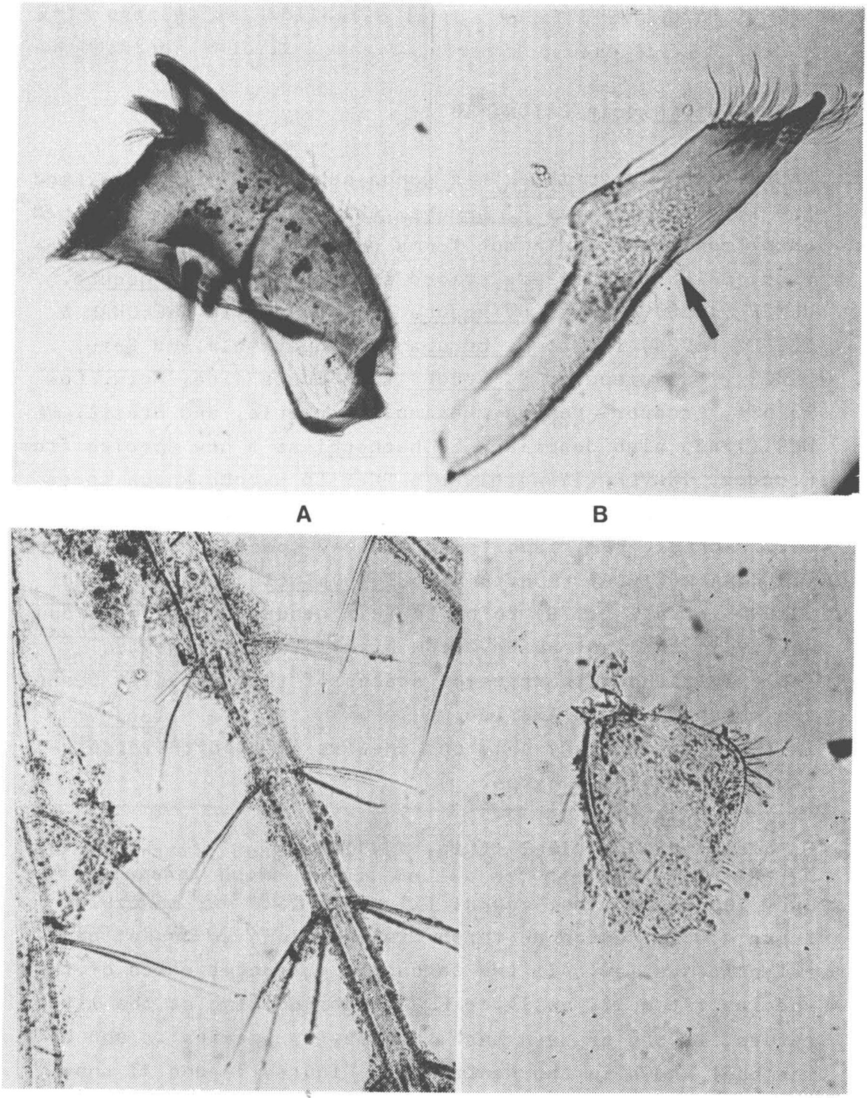


Fig. 28. Tricorythodes sp. A) nymph (covered with fine sand grains), B) claw, C) labrum, D) labium.



A B

C D

Fig. 29. Tricorythodes sp. A) right mandible, B) maxilla, C) caudal filaments, D) gill on 2nd segment.

FAMILY EUTHYPLOCIDAE

Genus *Euthyplocia* EATON, 1871

HAGEN (1861) described this genus sub nom. *Palingenia*, and the type species was *P. hecuba*; this species was described both from adult and nymph forms collected in Veracruz, Mexico. EATON (1871) redescribed it as *Euthyplocia hecuba*. ULMER (1920) reports *E. hecuba* from Venezuela. NEEDHAM & MURPHY (1924) report *E. hecuba* from Guatemala and Peru. ULMER (1942) reports *E. hecuba* from Costa Rica, Peru, Colombia, Ecuador, Panama, Mexico, Venezuela, and Brazil. ULMER (1942) also describes *E. haenschi* as a new species from Ecuador. TRAVER (1944) gives a "Key to nymphs known to occur in or near Brazil", and *Euthyplocia* is included in this key. PACKER (1966) reports an unnamed species from Honduras, and ROBACK (1966) reports also *Euthyplocia* sp. from Peru. EDMUNDS et al. (1976) refer to this genus as a wide spread mayfly in the neotropics, from Brazil to north Mexico.
Table XVII shows the present status of this genus in Central and Northern South America.
In the present study only one species is reported, represented by a single nymph.

E. hecuba (HAGEN, 1861) (Fig. 30-31)
Material: 1 nymph
Body length 23,0 mm; caudal filaments 15.0 mm; mandible tusks 4.0 mm; antennae three times as long as tusks; general color yellow. All the taxonomic characteristics of this species fit quite well for *E. hecuba*. Looking at the literature, it can be seen that this mayfly species is one of the best known in the Neotropics. Figures 30 and 31 show some of the most important characteristics of this species.

This species was collected in Rio Anori (Providencia), which means that it lives in clear and warm waters.

TABLE XVII. Species of the genus <u>Euthyplocia</u> EATON reported in Central and Northern South America.

Species	(1) Country										
	Br	Co	CR	Ec	Gu	Ho	Me	Pa	Pe	Su	Ve
x <u>E. haenschi</u> ULMER				X							
<u>E. hecuba</u> (HAGEN)	X	X	X	X			X	X	X		X
<u>Euthyplocia</u> sp. (PACKER, 1966)						X					
<u>Euthyplocia</u> sp. (ROBACK, 1966)									X		

(1) Br=Brazil, Co=Colombia, CR=Costa Rica, Ec=Ecuador, Gu=Guatemala, Ho=Honduras, Me=Mexico, Pa=Panama, Pe=Peru, Su=Surinam, Ve=Venezuela.

x Species described from adults.

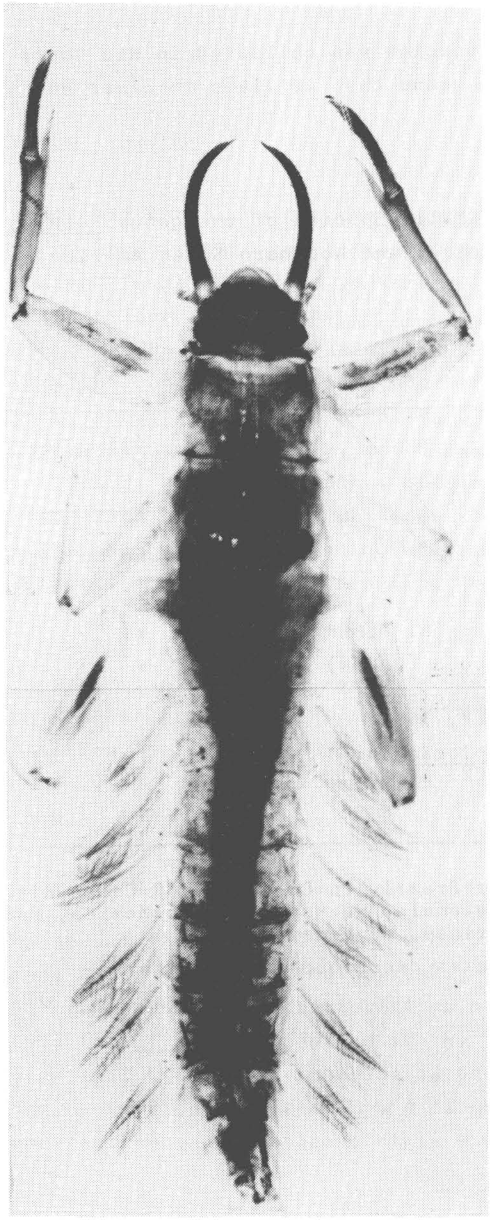
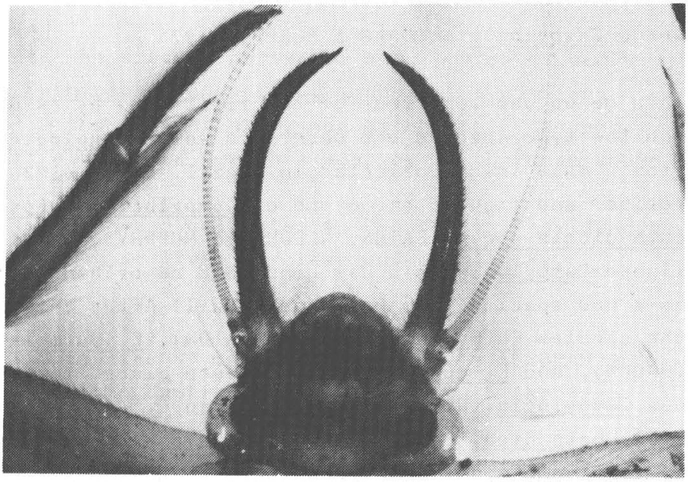
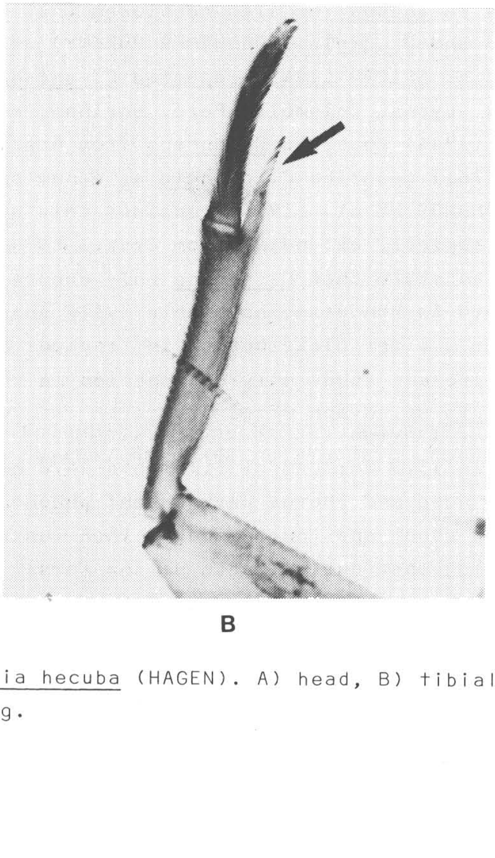


Fig. 30. Euthyplocia hecuba (HAGEN).



A



B

Fig. 31. Euthyplocia hecuba (HAGEN). A) head, B) tibial spine on foreleg.

Genus Campylocia NEEDHAM & MURPHY, 1924

This genus was reported for the first time by EATON (1883) and the type species was described as *Euthyplocia anceps* from a male imago collected in Brazil. ULMER (1920) described and figured the nymph of *Campylocia anceps* as *Euthyplocia anceps* EATON. NEEDHAM & MURPHY (1924) established *Campylocia* as a new genus and described *C. ampla* as a new species from Peru and Brazil. After this change, the species *Euthyplocia anceps* (EATON), *E. burmeisteri* (HAGEN), and *E. guntheri* (NAVAS) were placed into the genus *Campylocia*. ULMER (1942) reported *C. anceps* from Brazil, Costa Rica, Ecuador, French Guayana, and Colombia; in this same paper ULMER considers that *C. burmeisteri* (HAGEN) is a synonym of *C. anceps* (EATON), and keeps this species as *anceps*; he also concluded that *C. guntheri* (NAVAS) and *C. ampla* (NEEDHAM & MURPHY) were synonyms for *C. anceps*. SPIETH (1943) reported *C. anceps* from Brazil British Guyana, Colombia, Peru, Surinam, and Venezuela. TRAVER (1944) reported *C. anceps* from Brazil. BERNER & THEW (1961) describe *C. dochmia* as a new species from Brazil. EDMUNDS et al. (1976) consider this genus as principally tropical, extending from Brazil to North Honduras; they also state that *C. anceps* only occurs from Panama northward to Honduras, but Table XVIII shows that this species has a wider distribution in tropical America.

In the present study only one species is reported.

Campylocia sp. Nymph (Fig. 32)

Material: 1 nymph

Body size 13,5 mm; caudal filaments 14.0 mm; mandible tusks 2,5 mm; head and thorax dark-brown; abdomen yellow-brown; antennae about one-fourth longer than tusks; tibial spine of foreleg one-fourth length of the tarsi. Figure 32 shows some of the most important characteristics of this species.

According to the species described and figured by ULMER (1920) as Euthyplocia anceps (C. anceps) the specimen collected in the present study may belong to C. anceps. Table XVIII also shows how this species is the best known in the tropics.
This mayfly nymph was collected in Rio Anori (Providencia) which means that it lives in clear and warm water.

TABLE XVIII. Species of the genus Campylocia NEEDHAM & MURPHY reported in Central and Northern South America.

Species	(1) Country								
	Br	Co	CR	BG	FG	Ho	Pe	Su	Ve
x C. ampla NEEDHAM & MURPHY	X		X				X		
x C. anceps (EATON)	X	X	X	X	X		X	X	X
x C. dochmia BERNER & THEW	X								
x C. guntheri (NAVAS)		X							
Campylocia sp. (ROBACK, 1966)						X			

(1) Br=Brazil, Co=Colombia, CR=Costa Rica, BG=British Guyana, FG=French Guyana, Ho=Honduras, Pe=Peru, Su=Surinam, Ve=Venezuela.

x Species described from adults.

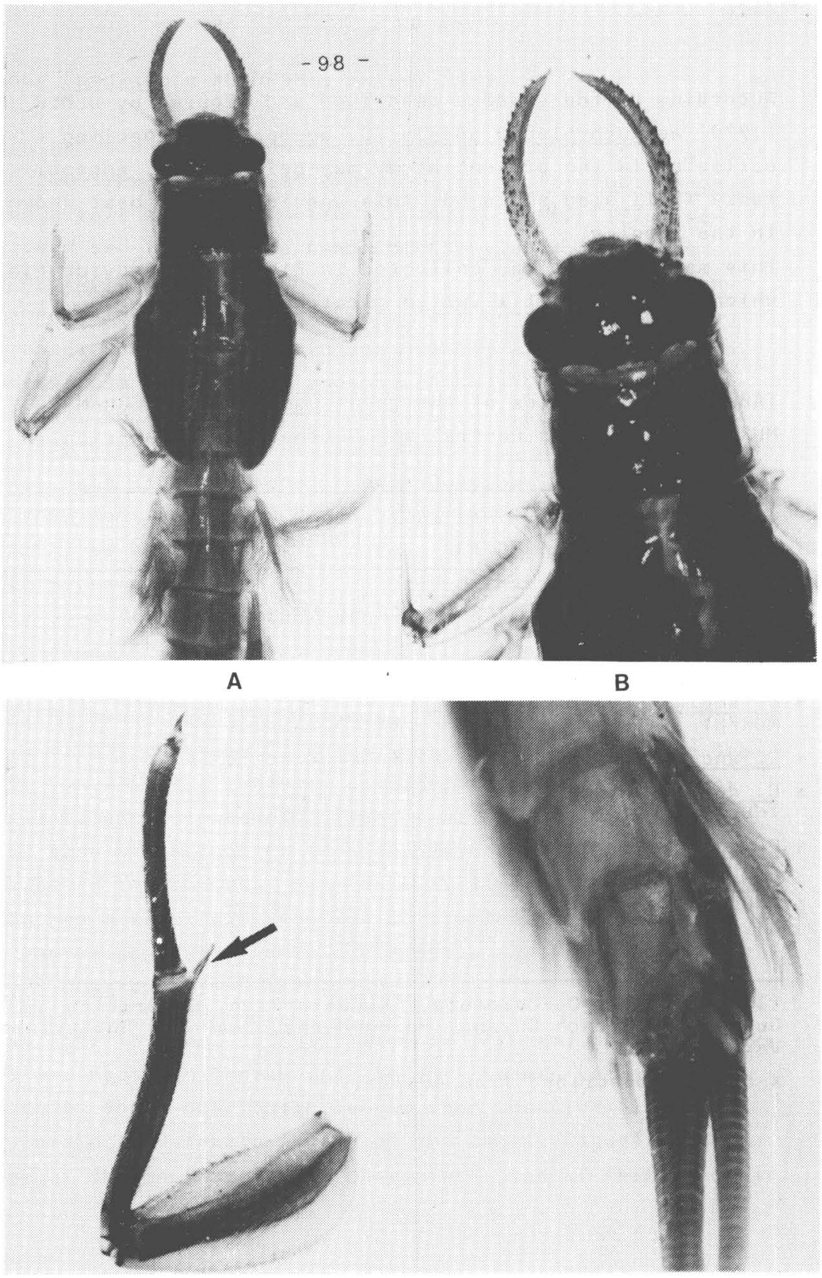


Fig. 32. <u>Campylocia</u> sp. A) nymph, B) head, C) foreleg showing the tibial spine, D) caudal filaments.

DISCUSSION OF RESULTS

Physicochemical

The physicochemical parameter that showed more stability with time was temperature. This means that organisms which live in tropical aquatic ecosystems are estenothermic and any change in temperature by only a few degrees can be deadly for at least part of the community.
Oxygen and carbon dioxide suffered more changes during the time of this study. In general, oxygen concentrations had the tendency to increase during rainy seasons and decrease in dry seasons. This may be due to the aireation of water which reaches the maximum level in the rainy season, and to the higher oxygen demand at low water level in the dry season, when organic matter is accumulated. Oxygen showed also great fluctuations in Rio Rionegro and Rio Medellin, but in this case, this was due mainly to organic pollution.
Carbon dioxide concentrations had the tendency to change inversely with that of oxygen, which in part, is expected to be logical in natural conditions.
Another factor that plays an important role for the stability of aquatic communities is pH. The greatest variation of this parameter was reported in Rio Medellin.
Conductivity showed also a high correlation with precipitation and pollution conditions. The higher the conductivity, the lower the species diversity. Rio Medellin showed also a high conductivity during this investigation, in comparison with the other three stations, where it was low and relatively stable.
Nitrates and phosphates showed no significant changes which can be regarded as responsible for drastic alterations in the aquatic community structure. In general, they changed rhythmicly with the dry and rainy seasons and showed a tendency to increase or decrease with conductivity.

Turbidity showed also a great variability directly related to the rainy seasons. A high turbidity decreases the primary productivity in water and interfers with the normal activity of mayfly gills.

In summary, from the data gathered it can be seen how tropical ecosystems show only small changes in their physicochemical characteristics with time. These changes follow mainly the rainy and dry seasons. Turbidity is the parameter that shows more drastic changes. This stability is a positive factor for the development of more complex and diversified communities. Rio Anori and Quebrada La Agudelo fall into this category (Figs. 33A and 34D). But at the same time it is evident how tropical ecosystems are very sensitive to environmental changes which reduces and simplifies their communities. In the present study, Rio Medellin and Rio Rionegro are examples of this situation (Fig. 33B and 34C).

Biological

Table VI shows the families and genera found in the present study. Family LEPTOPHLEBIIDAE followed by BAETIDAE and TRICORYTHYDAE, were the most representative, both with respect to species as well as to the total number of individuals collected.

Genus Baetis LEACH, although it is a cosmopolitan genus, is still one of the most poorely known in the Neotropics. It is unfortunate for the present study that most of its species have originally been described from adults. The genera Dactylobaetis TRAVER & EDMUNDS and Baetodes NEEDHAM & MURPHY are better known than Baetis LEACH, not only in respect to the different species, but also to their geographical distribution. These two general have the advantage for the present study that all of them have been described from nymphs.

Lachlania HAGEN is still poorely known in the Neotropics and most of its species have been described from adults. In the present investigation two species were found only in Quebrada La Agudeolo; thus, these two species may be regarded as indicators of clear and unpolluted water. Thraulodes ULMER is the best known genus in tropical America. It is the only mayfly genus whose type locality is Colombia. Unfortunately for the present study most of the known species have been originally described from adults, and still there are several reports as "unknown" species. In the same family to which Thraulodes belong, the LEPTOPHLEBIIDAE, the genus Hermanellopsis DEMOULIN and a "leptophlebiid" nymph are also reported; the first one still poorely known in tropical America, and the second one, whose characteristics do not fit into the description for the known genus of this family, remains herein undescribed. The family TRICORYTHIDAE is represented by two genera: Leptohyphes EATON which was the most abundant and wide spread genus found in the present study, and Tricorythodes ULMER, restricted only to Rio Rionegro.
The family EUTHYPLOCIDAE was represented by two genera: Euthyplocia EATON and Campylocia NEEDHAM & MURPHY, both of them typical neotropical genera, but still poorely known. In the present study they were found only in Rio Anori and each one was represented by a single specimen. Table XIX and figures 33 and 34 offer some interesting information that is worthwile to discuss. Rio Anori was the only station where most of the reported genera were found. Twenty species out of 24, were found here. A high predominance of Leptohyphes sp. No.1, followed by Baetodes sp. No.1, Baetis sp. No.1, and Thraulodes sp. No.1 and 2, was observed. This means that a tropical ecosystem with a fairly warm water and free of pollution offers ideal conditions for the establishment of complex and diversified benthos communities.

On the other hand, Quebrada La Agudelo which is an ecosystem almost free of pollution but with colder water ten species less were observed, represented by Thraulodes sp. No.1,2,3, and 4, followed by Baetis sp. No.2, Baetodes sp. No. 2, Lachlania sp. No.1 and 2, and Leptohyphes sp. No.1 and 2. These species can, thus, be regarded as indicators of cold and unpolluted water, according to the ILLIES (1969) classification.
Rio Medellin, which is highly degradated by pollution and sand extraction, presents a reduced fauna, represented only by four genera: Leptohyphes sp. No.1 and 2, followed by Dactylobaetis sp. and Baetis sp. No.3. These species show, thus, a great capacity of adaptability to different ecosystems and pollution conditions.
Rio Rionegro of cold and moderately polluted water, shows a community structure composed mainly of the all species of Leptohyphes, Dactylobaetis sp., Tricorythodes sp., followed by Thraulodes sp. No.1 and 3, Baetodes sp. No.1 and 2, and Baetis sp. No. 3 and 4. The presence of Tricorythodes sp. in Rio Rionegro only, can be regarded as a genus indicator of predominance of silty conditions in a particular water ecosystem.
The Presence of four species of Thraulodes, out of a total of five, in both Rio Anori and Quebrada La Agudelo, means that this genus may have a wide range of distribution in altitude. It is, however, sensitive to pollution conditions. However, Thraulodes sp. No.1 and 3 seem to tolerate amoderate pollution. Both species of Lachlania appear to belong to the cold water group, and Euthyplocia hecuba and Campylocia sp. to the warm water group.
On the other hand, the four species of the genus Baetis and the three species of the genus Leptohyphes show a great adaptability to different ecosystems and pollution conditions. Natural ecosystems characterize by having

many species and few individuals for species. But conditions, like pollution, may bring a decrease in diversity of species in an ecosystem, and consequently an increase in number of a particular species. This is the case, for example, of Rio Medellin in which more than 90% of the community structure is represented by Leptohyphes sp. No. 1 and 2. The genus Leptohyphes represents, thus, an example of a Ephemeroptera of wide range of distribution and great adaptability to pollution conditions.

From Table VII it can also be seen that Leptohyphes (3 species) was the predominant genus collected (39.74% of the total collection), followed by Baetodes (4 Species, 17,23%), Thraulodes (5 species, 15.56%), and Dactylobaetis (1 species, 11.97%). Baetis (4 species, 8.39%) occupies only the fifth place in the collection, which was really a surprise, since this species was expected to be the most abundant one according to literature.

The presence of five families from 11 reported in Central and South America, and 10 genera from about 30 known in the Neotropics, can be seen as a highly satisfactory result.

In particular if considers the fact that the area studied in the present investigation was relatively restricted ecologically compared with the great diversity of the tropical ecosystems.

Indeed, future investigations in other regions of Colombia, and in the Neotropics in general, will show much more diversity of families, genera, and species than were reported here this first investigation

TABLE XIX. Number and percentage in which each species is represented in the total community of each sampling station.

	Rio Anori unpolluted warm		R. Medellin highly polluted warm		R. Rionegro moderate polluted cold		Q.Agudelo unpolluted cold	
	No.	%	No.	%	No.	%	No.	%
1.Baetis sp. No.1	64	7.94	-	-	-	-	-	-
2.Baetis sp. No.2	4	0.49	-	-	-	-	28	20.28
3.Baetis sp. No.3	-	-	4	1.95	20	3.83	-	-
4.Baetis sp. No.4	12	1.48	-	-	8	1.53	-	-
5.Baetodes sp..No.1	166	20.59	-	-	18	3.44	-	-
6.Baetodes sp. No.2	24	2.97	-	-	19	3.63	13	9.42
7.Baetodes sp. No.3	28	3.47	-	-	-	-	-	-
8.Baetodes sp. No.4	20	2.48	-	-	-	-	-	-
9.Dactylobaetis sp.	60	7.44	12	5.85	128	24.52	-	-
10.Lachlania sp. No.1	-	-	-	-	-	-	10	7.24
11.Lachlania sp. No.2	-	-	-	-	-	-	6	4.34
12.Thraulodes sp.No.1	61	7.56	-	-	19	3.63	16	11.59
13.Thraulodes sp.No.2	57	7.07	-	-	-	-	15	10.86
14.Thraulodes sp.No.3	34	4.21	-	-	20	3.83	14	10.14
15.Thraulodes sp.No.4	5	0.62	-	-	-	-	15	10.86
16.Thraulodes so.No.5	4	0.49	-	-	-	-	-	-
17.Hermanellopsis sp.	1	0.12	-	-	-	-	-	-
18."Leptophlebiid"	4	0.49	-	-	-	-	-	-
19.Leptohyphes sp.No.1	188	23.32	113	55.12	150	28.32	13	9.42
20.Leptohyphes sp.No.2	36	4.46	76	37.07	28	5.36	8	5.79
21.Leptohyphes sp.No.3	36	4.46	-	-	16	3.06	-	-
22.Thricorythodes sp	-	-	-	-	96	18.39	-	-
23 Euthyplocia hecuba	1	0.12	-	-	-	-	-	-
24 Campylocia sp	1	0.12	-	-	-	-	-	-

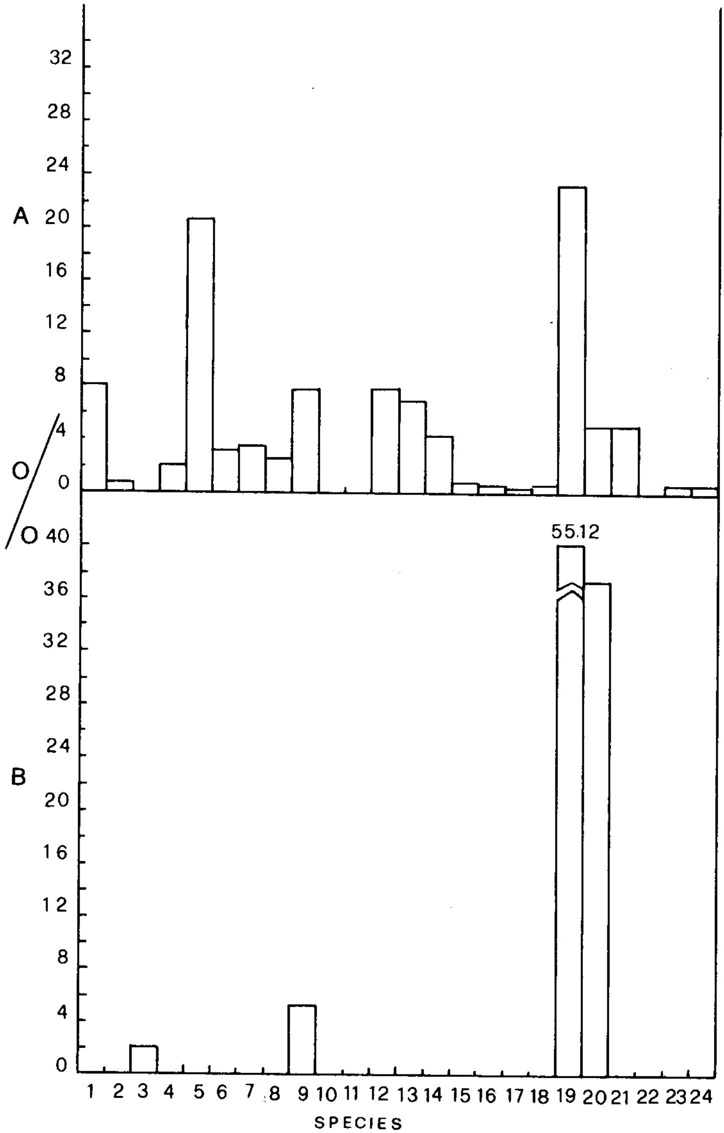


Fig. 33. Mayfly community structure in A) Rio Anori, and B) Rio Medellin (For species number identification see Table XIX).

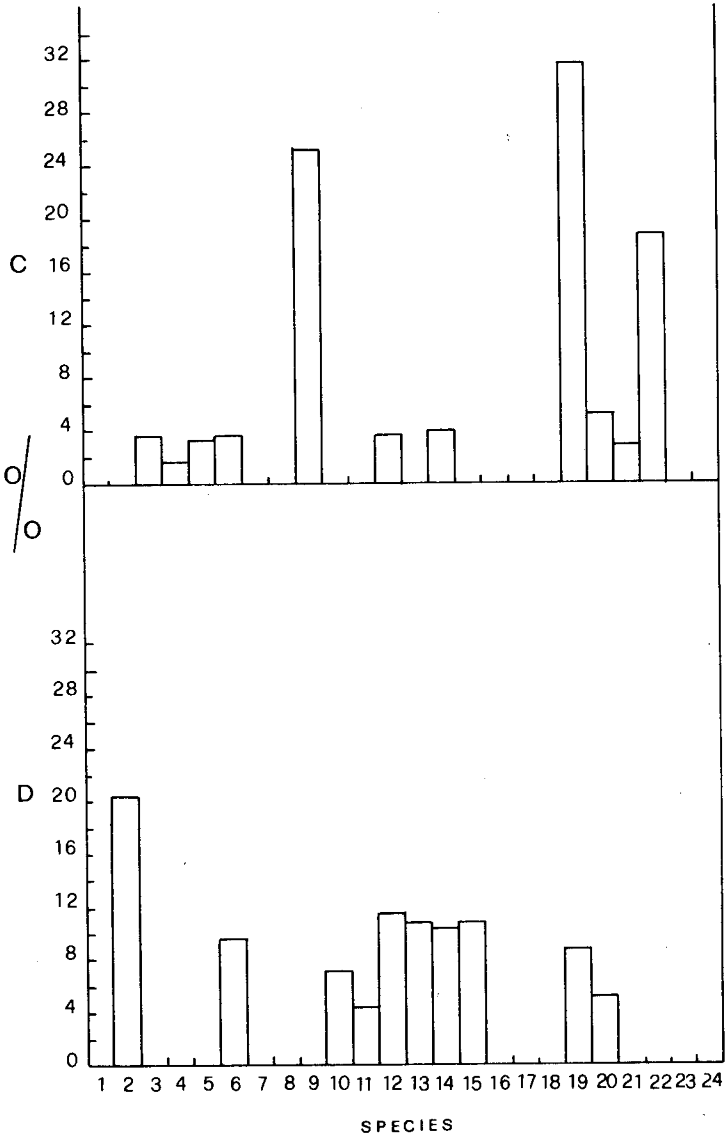


Fig. 34. Mayfly community structure in C) Rio Rionegro, and D) Quebrada La Agudelo (For species number identification see Table XIX).

SUMMARY

1) Samples for physicochemical and biological analyses were taken every four months in Rio Anori (Providencia) from March, 1973 to December, 1975. Monthly samples were taken in Rio Medellin (Primavera) from November, 1973 to October, 1974; in Rio Rionegro (El Tablazo) and in Quebrada La Agudelo (El Retiro) from March, 1975 to February, 1976.

2) Temperature was found to be the most constant factor, changing only between 1.0 and 2.0 °C through the entire study.

3) Oxygen content was high in cold and unpolluted waters showing a decrease with higher temperatures and pollution.

4) Carbon dioxide concentration ran inversely to that of oxygen. Its values were in general, between 20.0 and 8.0 mg/l.

5) pH was in the neutral or slightly acid side in all the ecosystems studied. Under pollution conditions, this parameter showed greater changes.

6) Turbidity was the factor that showed more striking changes which were found strongly correlated with rainy and dry seasons. Erosion and sand extraction activities contribute to increased turbidity.

7) Hardness and alkalinity were in general low between 8-30 mg/l and showed not significant changes.

8) Nitrates and phosphates were also in general low between 0.01 - 1.0 mg/l. with little increase during dry season and pollution conditions. Conductivity, a measure

of the total amount of ions in water, ran parallel to these two parameters.

9) Regarding the mayfly fauna, 24 species were found belonging to ten genera of five families.

10) Rio Anori was found to be the ecosystem that showed the greatest diversity of species, and Rio Medellin, the lowest.

11) Both species of the genus Lachlania seem to prefer cold and unpolluted water; Euthyplocia hecuba and the species of the genus Campylocia were more frequent in warm and unpolluted water.

12) Tricorythodes and Dactylobaetis can regarded as genera indicators of predominantly silty conditions in water.

13) Leptohyphes, Baetis, and Baetodes showed a great adaptability to different ecosystems and pollution conditions.

14) Thraulodes showed a wide range of distribution in altitude, but is very sensitive to pollution.

15) Hermanellopsis is still a very unknown genus in the Neotropics.

16) In general oxygen, pH, and turbidity were the factors that had more influence on the reduction and simplification of the mayfly community structure.

17) Literature about neotropical mayflies is incomplete and scattered. For correct identification at species level, a key must be constructed on regional bases.

18) At the genus level, a key based on EDMUNDS et al. (1976) was constructed for the known neotropical mayflies.

19) Among the Neotropics Colombia is one of the countries in which least work has been done on mayflies.

20) Based on the present literature and on the results of this study it can be inferred that a complete revision of the taxonomy of neotropical mayflies and a begin-ing of limnological studies is needed. At present there are almost unexistent, especially in Colombia.

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	1966-1970	Professor of Biology, Univ. de Antioquia Medellin, Colombia
	1970-1974	Head Department of Biology, Univ. de Antioquia Medellin, Colombia.
	1976-1977	Head Marine Biology Institute, Santa Marta, Colombia.
	1977-1979	Professor of Ecology and Limnology, Univ. de Antioquia, Medellin, Colombia.
	1979-1980	Gesamthochschule Kassel, (West Germany) Universität des Landes Hessen, awarded with an Alexander von Humboldt Fellowship.