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MUSEUM OF ZOOLOGY
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MOLLUSCA OF PETÉN AND
NORTH ALTA VERA PAZ,
GUATEMALA

BY
CALVIN GOODRICH AND HENRY VAN DER SCHALIE

ANN ARBOR
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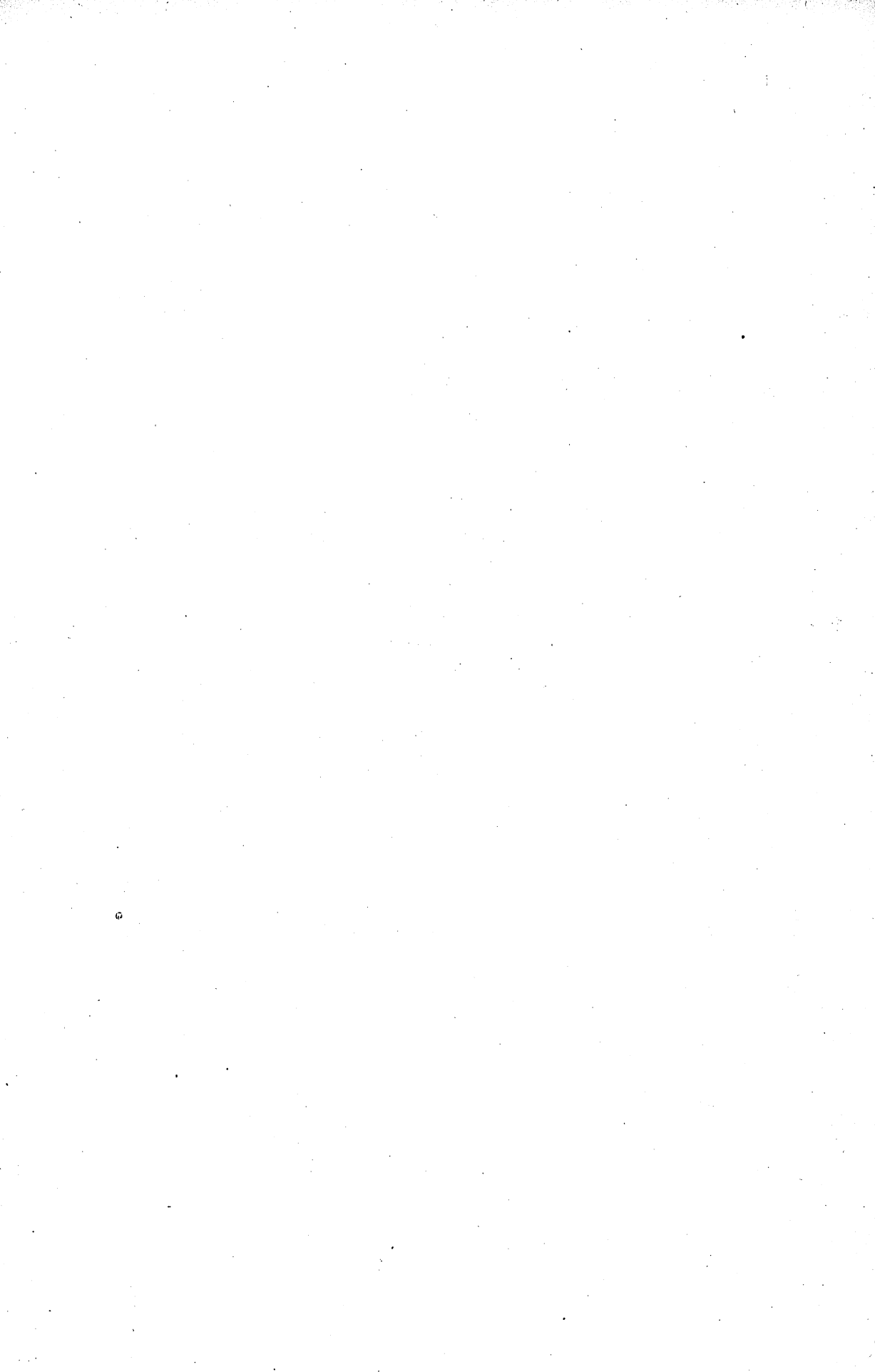
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FREDERICK M. GAIGE
Director of the Museum of Zoology

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CONTENTS

	PAGE
INTRODUCTION	7
ACKNOWLEDGMENTS	10
LIMNOLOGICAL DATA	10
ECOLOGY	
LAND SHELLS	11
FRESH-WATER SHELLS	16
ZOOGEOGRAPHICAL RELATIONS	19
THE MOLLUSCAN FAUNA	23
REFERENCES	47

MOLLUSCA OF PETÉN AND NORTH ALTA VERA PAZ, GUATEMALA

INTRODUCTION

This paper is concerned with the mollusca collected by the fourth Carnegie Institution—University of Michigan expedition into Mayan America. The region in which intensive work was carried out is the interior drainage basin, the area of the headwaters of the Río San Pedro de Mártir and that of the lower reaches of the Río de la Pasión, all three in the Department of Petén, Guatemala; and in addition the upper parts of the Río de la Pasión where it issues out of the Department of Alta Vera Paz and flows through Petén. The junior author of this paper devoted his time and energies to mollusca, while Dr. Carl L. Hubbs, in charge of the expedition, concentrated his attention on the collection of fishes; yet at periods each worked in the other's field.

The expedition landed at Puerto Barrios on January 31, 1935, and went immediately to Guatemala City by rail to conduct the necessary negotiations with the customs offices and to arrange for transport northward. The wait at Guatemala City consumed four days. It was possible to visit the near-by Lake Amatitlán and to examine cursorily the fauna of the Río Guacalate and Río Michatoya, which drain into the Pacific Ocean. The journey to Flores on Lake Petén was made by airplane, the entire trip taking less than two hours in contrast to the trying land journeys by mule-back which ordinarily require ten days or more. The upland plain about Guatemala City is deeply dissected and, from above, appears to be nearly devoid of vegetation. The airplane rose to an altitude of 9000 feet in order to clear the east-west mountains north of the capital. As progress is made northward, the mountains decrease in height and ruggedness and show by their greater cover an increase in rainfall over that in the neighborhood of Guatemala City. This is further indicated by the broader cultural areas, large tracts in the district of Cobán being given over to coffee growing. The elevation of this region is about 3000 feet above the sea. Still farther north, the country becomes more level, and the vegetation is a thick tropical mat through which streams flow in broad loops and meanders. This is the lowland bush traversed by the Río de la Pasión which joins with the Río Salinas to form the Río Usumacinta. Beyond the Pasión appear patches of savanna, dotted with knolls of limestone outcroppings and *aguada* pools, and after that the lakes and arroyos in the proximity of Flores.

A base was established at Flores. From here it was possible to make studies of the limnological conditions and fauna of Lake Petén, of the lesser

lakes about it, of the districts that are under cultivation or have been in the past, and of numbers of limestone knolls and woodlands. Only the western end of Lake Petén was visited, but there is every reason to believe that this part is representative of the whole lake and does not differ in its fauna from any other of the shores.

Flores was an ancient outlier of the Mayan civilization. It became an isolated settlement of the Spaniards in the colonial period and a caravan-sary of the mule trains of traders, churchmen, and civil authorities between Mexico to the north and the communities on the south. The fauna betrays the effect of prolonged human cultural endeavors, but not to the degree apparent in the contiguous peninsula of Yucatan. It was at Flores that Arthur Morelet, the first naturalist to penetrate the country, spent several months in 1847. He had come from Yucatan to one of the mouths of the Río Usumacinta, by boat upstream and then overland by trail to Flores. His collections have formed the basis of all the understanding of the fauna of North Guatemala. That these same collections have proved to be incomplete and in places in error is due not to Morelet's failings as a naturalist, but to the fact that he was long ill with the local ailments and had to trust much of his work to persons, some of them school children, whom he instructed from his hammock. Osbert Salvin went into Petén from Cobán on foot in 1861. The few mollusks he collected were merely incidental to ornithological studies. In 1933 Dr. L. C. Stuart of the third Carnegie Institution-University of Michigan expedition brought away a mass of the drift shells which accumulate on the beaches at the east end of Lake Petén. The material was made up of thirteen species. Between Morelet's time at Flores and that of the present expedition nearly ninety years intervened.

In 1935 Lake Petén was in the cycle of high levels. "Drowned" trees were standing in depths of ten feet or thereabouts. These levels, however, were not the most extreme that the lake has undergone. In the ant hills, thirty or forty feet above the present water line, are quantities of shells of aquatic origin identical with those now washed up on the beaches.

The second part of the exploration was made into the region bordering the Río San Pedro to the northwest of Flores. Mr. William S. Officer, connected with the chicle industry, kindly served as guide. The trails followed the north shores of the river expansions known as Laguna de Zotz and Laguna Perdida. These paths are bordered by dense woods for the most part, and they are intercepted by limestone ridges of the characteristically regional degradation. Living and working quarters were obtained at El Paso de los Caballos through the courtesy of representatives of the Chicle Development Company. From this locality, boats were taken to the Laguna de Yalac nearer to the sources of the Río San Pedro, and later the junior author

journeyed sixty miles downstream to the Mactún rapids where the river ceased to be sluggish and lakelike for the first time during this trip.

Return was made to Flores, and from here a third exploration was undertaken. The first stop was made at the home of Mr. O. A. Taintor in La Libertad. Mr. Taintor is an American who has long been identified with the mahogany logging and the chicle industry of North Guatemala. Under his guidance visits were made to the *aguadas* of the vicinity. These are shallow depressions in the limestone, and contain the only accumulations of water of the area that are left after the end of the wet seasons. Without them the cattle raising of the region would be restricted to a few months of the year. The molluscan fauna of these "sinks" is small. Besides the rigor of the environment, the colonies must undergo the disadvantages that cattle-trampling brings. La Libertad was particularly convenient to the savannas, in which collections were made at several points. The limestone knobs, breaking the monotonous surface of the savannas, were each found to harbor molluscan populations of varying numbers of species. The Arroyo Subín, which borders the Taintor ranch, Santa Teresa, was also studied.

After a few days at Santa Teresa, the members of the expedition were taken from the mouth of the Subín in a large *cayuca*, or dug-out canoe, which was propelled by an outboard motor, and thence upstream to the source of the Río de la Pasión so far as navigation by any craft was feasible. Going upstream, the river was deep and of feeble current until Santa Amelia was reached. From this point approximately sixty-five rapids were encountered. Travel involved arduous labor in dragging the *cayuca* over stones, and a loss of time, which brought the supply of food nearly to exhaustion. Reprovisioning was accomplished through the kindness of Don Carlos Vidaurre, a *patrón* of the Cobán district. Several villages are marked on the maps of this part of the upper Río de la Pasión. They exist no longer. With the decay of the timber trade went the decay of these communities. Sayaxché is the only place of the area that still deserves designation as a town. The river proved to be of great interest as regards the mollusca it contained, not simply by reason of species hitherto unknown to science, but also because some of the other species have been reported as from the lower Río Usumacinta in Mexico or tributaries thereto.

The geology of Guatemala has been studied by Sapper (1894). Stuart (1935) has reported on that of the savanna country of Petén. It need be said here only that the superficial deposits of Petén are Tertiary and Quarternary. The limestone outcrops are probably of Cretaceous age. They have undergone extensive disintegration, the worn-down knolls corresponding to the *megotos* of Cuba, that seemingly are the mere remnants and relics of once high hills and ridges. The solvent powers of surface waters have

caused the depressions spoken of as *aguadas*, the purer limestone having been dissolved away and leaving the less pure and more resistant limestone as shores or banks. The upper Río de la Pasión runs as a northern rim of the elevated Alta Vera Paz. The divides between the interior drainage basin of Lake Petén and that of tributaries of the Río Usumacinta are low, but they are apparent enough to the traveler on mule-back and are still more sharply defined when viewed from an airplane.

ACKNOWLEDGMENTS

The expedition fell early under obligation. At New Orleans, Mr. Percy Viosca, Jr., made the way easy for departure by steamer and, among other kindly offices, furnished equipment useful for the field. At Guatemala City, Dr. Oliver P. Ricketson, Jr., in charge of the Carnegie Institution work there, together with his staff, supplied direction and advice that later proved invaluable, besides aiding in the preparations for the exploration. Señor Ponce, the governor of Petén, showed a sincere and encouraging interest in the work and, through that, enlisted aid at Flores that might otherwise have been difficult to command. To Messrs. S. S. Yates, A. Moysey Adams, and Robert C. Porter, officials of the Chicle Development Company, are due acknowledgments for innumerable favors, not the least of which were their friendliness toward the purposes of the expedition and endeavors to relieve the strangers of mishaps with the local dialects. Señor Ruben Alvarado of Flores went to pains to anticipate many needs, and the industrious and faithful Francisco Satina of the same place took upon himself burdens of sometimes trying character. Mr. William S. Officer guided the party to El Paso de los Caballos, for the first time visited by any students of the Guatemalan fauna. Particularly, it is necessary to avow a heavy debt to Mr. O. A. Taintor, "Don Alfredo," whose hospitality was matched only by his own energy and readiness to be of service. Upon the upper Río de la Pasión, the provisions of the party ran low and immediate return would have been necessary had it not been for Don Carlos Vidaurre of Cobán who, at cost of time and trouble to himself, arranged for the new supplies. During the course of identifying the Guatemalan material in the Museum of Zoology, dilemmas developed that were overcome only through the help of Dr. H. A. Pilsbry of the Philadelphia Academy of Natural Sciences and the foremost authority on Latin American mollusca. Dr. H. B. Baker of the University of Pennsylvania kindly identified the slugs that had been collected, and Mr. William J. Clench of the Museum of Comparative Zoology did a like courtesy with the specimens of the difficult family of Physidae.

LIMNOLOGICAL DATA

In Lake Petén, on February 12, 1935, a series of soundings revealed that the bottom of the lake sloped downward in a north direction, showing that

the lake lies in a trough which has a steep north shore and a gently sloping south shore. The maximum depth recorded was approximately forty-five meters. Surface waters, tested by the Rideal-Stewart modification of the Winkler method, showed an abundance of dissolved oxygen (13.73 p.p.m. at 25° C.), and the Methyl Orange alkalinity readings indicated a plentiful supply of carbonates for the production of shell material, the readings ranging in the neighborhood of 80-90 p.p.m. The pH readings, taken with a Hellige Color Disc comparator, were found to be about 8.2.

Some of the other small inland lakes of this region gave somewhat similar results for surface samples. In Laguna de Eckixil, the surface waters had a pH of 8.2, a Methyl Orange alkalinity of 110 p.p.m., and considerable dissolved oxygen (8 p.p.m. at 27° C.). Laguna de Eckibix, located on the savanna about twenty-five miles south of Flores, had a pH of 8.1, a Methyl Orange alkalinity of 72 p.p.m., and a large amount of dissolved oxygen (12.44 p.p.m. at 25° C.). Laguna Perdida, located along the trail from Flores to El Paso de los Caballos, had a paucity of fresh-water mollusks, though tests of its surface waters indicated an abundance of oxygen, a pH of 8.6, and a Methyl Orange alkalinity of 93 p.p.m.

At El Paso de los Caballos, the Río San Pedro was deep, sluggish, and almost lakelike in character. Its waters were favorable for the propagation of mollusks, as was shown by the abundance of dissolved oxygen, a pH of 7.0, and Methyl Orange alkalinity of 215 p.p.m. Mussels were abundant on shoals in this river.

The Río de la Pasión differed decidedly in appearance from other bodies of water investigated. This was particularly true of the lower, deeper portions where the water had a chalky blue color. Analyses gave pH readings varying from 7.6 to 8.1, and Methyl Orange alkalinity readings of about 163 p.p.m., conditions which help to account for the large shell fauna found in this river.

This résumé of limnological conditions does not include all of the data obtained by the expedition. A more detailed account of the limnological findings will perhaps be published later.

ECOLOGY

LAND SHELLS

The present expedition visited Guatemala during the period of the dry season, the months of February, March, and April. Very little rain fell during this time so that most land shells were in a state of aestivation. Some species were found in their haunts during this time, while others were represented in the collections merely by dead specimens. It becomes obvious that under such conditions and in the haste with which many of the collections were made, detailed ecological data could not be taken. Yet the three months

TABLE I
ECOLOGY OF LAND MOLLUSKS

	Savannas	Wooded Lowlands	Limestone Knolls	Outcrops on Limestone Knolls	Cleared Areas in Inhabited Regions	Stations along Rivers and Lakes
<i>Averellia coactiliata</i> Deshayes		x	x		x	x
<i>Averellia suturalis</i> Pfeiffer			x			
<i>Bothriopupa leucodon</i> Morelet						x
<i>Brachypodella speluncae</i> Pfeiffer				x		
<i>Bulimulus unicolor</i> Sowerby	x		x		x	x
<i>Caecilioides consobrina veracruzensis</i> C. and F.		x	x		x	x
<i>Carychium exiguum mexicanum</i> Pilsbry						x
<i>Chanomphala pilsbryi</i> H. B. Baker			x			x
<i>Choanopoma gaigei</i> Beq. and Clench				x		
<i>Chondropoma rubricundum</i> Morelet				x		
<i>Diplopoma radiosum</i> Morelet				x		
<i>Drymaeus shattucki</i> Beq. and Clench		x	x			
<i>Drymaeus sulphureus</i> Pfeiffer		x				
<i>Drymaeus tropicalis</i> Morelet			x			
<i>Euglandina cumingi</i> Beck	x	x	x		x	x
<i>Euglandina cylindracea</i> Phillips			x		x	
<i>Gastrocopta pentodon</i> Say				x		x
<i>Gastrocopta servilis</i> Gould			x			x
<i>Guppya gundlachi</i> Pfeiffer			x			x
<i>Guppya orosciana</i> Martens			x			
<i>Guppya pittieri</i> Martens			x			
<i>Habroconus trochulina</i> Morelet			x			x
<i>Hawaiiia minuscula</i> Binney			x		x	x
<i>Hawaiiia minuscula permodesta</i> Streb. and Pfr.		x				x
<i>Helicina amoena</i> Pfeiffer		x	x		x	x
<i>Helicina arenicola</i> Pfeiffer			x			
<i>Helicina flavida</i> Menke		x				
<i>Helicina oweniana</i> Pfeiffer		x	x		x	x
<i>Helicina oweniana coccinostoma</i> Morelet		x				x
<i>Helicina rostrata</i> Morelet			x			
<i>Helicina tenuis</i> Pfeiffer		x	x			x
<i>Leptinaria elisae</i> Tristram		x	x			x
<i>Leptinaria flicostata</i> Streb. and Pfr.		x				x
<i>Leptinaria guatemalensis</i> Crosse and Fischer					x	
<i>Leptinaria livingstonensis</i> Hinkley		x				
<i>Leptinaria martensi</i> Pfeiffer		x	x		x	x
<i>Leptinaria stollii</i> Martens			x			
<i>Lucidella lirata</i> Pfeiffer		x	x		x	x
<i>Megalomastoma simulacrum</i> Morelet		x				
<i>Microceramus concisus</i> Morelet				x		
<i>Microconus wilhelmi</i> Pfeiffer						x
<i>Opeas beckianum</i> Pfeiffer		x				x
<i>Opeas gracile</i> Hutton					x	x
<i>Opeas micra</i> D'Orbigny			x		x	
<i>Oxystyla princeps</i> Broderip		x				
<i>Polygyra yucatanica</i> Morelet						x
<i>Poteria dysoni</i> Pfeiffer		x	x		x	
<i>Practicolella griseola</i> Pfeiffer	x					

TABLE I—(Cont.)

	Savannas	Wooded Lowlands	Limestone Knolls	Outcrops on Limestone Knolls	Cleared Areas in Inhabited Regions	Stations along Rivers and Lakes
<i>Pyrgodomus microdina</i> Morelet			x	x		x
<i>Pupisoma dioscoricola</i> C. B. Adams			x			x
<i>Salasiella margaritacea</i> Pfeiffer		x	x			x
<i>Spiraxis alvaradoi</i> Goodrich and van der Schalie			x			x
<i>Spiraxis funibus</i> Goodrich and van der Schalie		x				x
<i>Sterkia eryiesii</i> Drouet			x			
<i>Streptostyla ligulata</i> Morelet			x			
<i>Streptostyla meridana</i> Morelet		x	x		x	x
<i>Streptostyla nigricans</i> Pfeiffer			x			
<i>Subulina cylindrella</i> Morelet		x				
<i>Thysanophora conspurcatella</i> Morelet						x
<i>Thysanophora impura</i> Pfeiffer						x
<i>Thysanophora plagioptycha</i> Shuttleworth			x			x
<i>Veronicella moreleti</i> (Grosse and Fischer)					x	
<i>Xenodiscula taintori</i> Goodrich and van der Schalie.....			x	x		x

in the field did permit an accumulation of material which showed that certain species were generally associated with certain ecological conditions. Roughly the following major ecological areas are recognized: 1 Savannas; 2 Wooded lowlands; 3 Limestone knolls and limestone outcrops; 4 Cleared areas in inhabited regions; 5 Stations along rivers and lakes.

1. Savannas

There are rather large savanna areas south of Lake Petén. Some of these, such as those in the region of La Libertad and Esperanza, are used for cattle grazing. The cattlemen set fire to the grass repeatedly so as to provide green food for the cattle, since a heavy dew seems to produce sufficient moisture to bring about the growth of a new crop. This burning is not without its detrimental effect on the mollusks inhabiting such areas. As one travels across the savannas there are often places where bleached specimens reveal the results of firing.

Only three species were found inhabiting the savanna:

Practicolella griseola

Bulimulus unicolor

Euglandina cumingi

Of these, *P. griseola* was found to be restricted to this habitat. It was never taken anywhere else, while the other two occurred also in other habitats.

2. *Wooded Lowlands*

Considerable areas of woodland, too low to support a fauna of land shells, are covered by pools of water during the long wet season. Often they dry completely before the end of this season. When one attempts to collect land shells from such places, it becomes a difficult task. In places where the moisture becomes too great over extended periods, no shells can be found, but usually some careful digging around the bases of trees yields a few. The trees, particularly palms, have raised their root systems considerably above the ground level. It is in the humus at the bases of trees that the following species were found to occur:

<i>Poteria dysoni</i>	<i>Lucidella lirata</i>
<i>Euglandina cumingi</i>	<i>Leptinaria martensi</i>
<i>Helicina amoena</i>	<i>Leptinaria elisae</i>
<i>Helicina oweniana</i>	<i>Pomacea flagellata</i>

The list contains species which are evidently very adaptable, since they occur in a wide range of habitats. There is none that might be cited as characteristic of this habitat, unless we include the fresh-water shell, *Pomacea flagellata*, which has on several occasions been found in just such situations. Often nothing else was present. The *Pomacea*, buried around the trees, was quite indicative of how flooded such an area becomes during the rainy season.

3. *Limestone Knolls*

In contrast to the fauna of the lowland areas, the more productive regions were the wooded limestone knolls in the region of Lake Petén and northwestward into the drainage of the Río San Pedro. These small hills were common in the two areas. Their fauna was quite characteristic. It was found that where the limestone actually outcropped several species could be added which otherwise did not occur. The fauna of the general area follows, with those species which were observed as definitely restricted to the zones of the outcrop given separately:

<i>Euglandina cylindracea</i>	<i>Guppya gundlachi</i>
<i>Euglandina cumingi</i>	<i>Habroconus trochulina</i>
<i>Streptostyla meridana</i>	<i>Hawaiiia minuscula</i>
<i>Salasiella minima</i>	<i>Drymaeus shattucki</i>
<i>Salasiella margaritacea</i>	<i>Leptinaria martensi</i>
<i>Thysanophora conspurcatella</i>	<i>Leptinaria elisae</i>
<i>Thysanophora plagioptycha</i>	<i>Poteria dysoni</i>
<i>Averellia coactiliata</i>	<i>Opeas gracile</i>
<i>Averellia suturalis</i>	<i>Opeas micra</i>

<i>Helicina amoena</i>	<i>Spiraxis alvaradoi</i>
<i>Helicina oweniana</i>	<i>Pupisoma dioscoricola</i>
<i>Helicina arenicola</i>	<i>Xenodiscula taintori</i>
<i>Helicina tenuis</i>	<i>Chanomphala pilsbryi</i>
<i>Lucidella lirata</i>	

Species restricted to outcrops:

<i>Brachypodella speluncae</i>	<i>Gastrocopta pentodon</i>
<i>Chondropoma rubicundum</i>	<i>Microceramus concisus</i>
<i>Diplopoma radiosum</i>	<i>Helicina rostrata</i>
<i>Eutrochatella microdina</i>	

4. Cleared Areas in Inhabited Regions

For centuries the land in Guatemala has been under cultivation. Yet at present comparatively little of it is being tilled. Milpa farming, a system by which only small patches of woodland are cleared by burning during the dry season, is still carried on. This process is naturally very disadvantageous to any land shells inhabiting the area. Some time after the clearing process, however, a number of species adapt themselves to the altered surroundings, and live under logs and stones strewn about the premises of the farm establishments. In such an area the following species were found:

<i>Veronicella moreleti</i>	<i>Leptinaria martensi</i>
<i>Euglandina cylindracea</i>	<i>Leptinaria guatemalensis</i>
<i>Euglandina cumingi</i>	<i>Poteria dysoni</i>
<i>Streptostyla meridana</i>	<i>Helicina amoena</i>
<i>Salasiella minima</i>	<i>Helicina oweniana</i>
<i>Hawaiiia minuscula</i>	<i>Helicina tenuis</i>
<i>Averellia coactiliata</i>	<i>Lucidella lirata</i>
<i>Bulimulus unicolor</i>	<i>Polygyra yucatanica</i>
<i>Opeas gracile</i>	

5. Stations Along Rivers and Lakes

It was obvious that certain species were invariably found close to lakes or drainage systems. This was particularly striking in the case of *Polygyra yucatanica* and *Thysanophora impura*. Not once were these found at any great distance from either a lake shore or the banks of a river. Associating with them there were usually several other species. A more or less typical assemblage of this type would include the following:

<i>Polygyra yucatanica</i>	<i>Spiraxis funibus</i>
<i>Euglandina cumingi</i>	<i>Hawaiiia minuscula</i>
<i>Streptostyla meridana</i>	<i>Thysanophora impura</i>

<i>Thysanophora plagiopycha</i>	<i>Pupisoma dioscoricola</i>
<i>Bulimulus unicolor</i>	<i>Gastrocopta servilis</i>
<i>Opeas gracile</i>	<i>Lucidella lirata</i>
<i>Guppya orosciana</i>	

It is not easy to dissociate a habitat of this type from the previous one, since, as in nearly all countries of the world, the people usually establish themselves on the shores of rivers and lakes. This would tend to cause an overlap in ecological conditions as listed above; and yet the complete absence of certain of the above species from both woodland and cleared areas not located near drainage systems, is sufficient proof of definite ecological and distributional differences. In this connection, the case of *Euglandina cylindracea* is worthy of mention since whenever found it was always within a radius of approximately five miles from the shore of Lake Petén.

FRESH-WATER SHELLS

The various bodies of water investigated by the present expedition might conveniently be grouped into four general categories: 1. *Aguadas*; 2. Lakes; 3. Arroyos; 4. Rivers.

1. *Aguadas*

The savanna country is by no means level. There are many depressions in it which fill with water during the rainy season. Many of these dry completely during the dry season, while others, the *aguadas*, remain more or less permanent water holes. These, particularly where they occur near populated areas, serve as watering places for the cattle grazing on the savanna. At the Aguada de Copó, about one mile south of La Libertad, for instance, it was obvious that the cattle did considerable damage to shells by wading. It is doubtful, however, whether this is great in its effect, since the fauna of the *aguadas* examined was found to be very restricted, both specifically and in abundance. It consisted of the following species:

<i>Ferrissia excentrica</i>	<i>Physa</i> (young and too small to identify)
<i>Ferrissia aguadae</i>	
<i>Gundlachia hjalmarsoni</i>	

Occasionally an *aguada* would prove very productive, as was the case in a small drying one located just southwest of San Benito, on the shores of Lake Petén. Here there was evidently an influx of species from Lake Petén, which gives quite a different result from that indicated above. This must be considered an unusual instance, and the species of the list would give a truer picture of the fauna in the average *aguada*.

2. *Lakes*

Lakes are fairly common in the Department of Petén. The largest in the territory is Lake Petén; it proved the most productive conchologically.

The lake level at the time the present expedition worked there was unusually high. As evidence of this we found that trees which formerly grew at the outlet of Arroyo Ponteil were completely covered with water so that our *cayuca* sailed above the dead trunks into the much flooded mouth of the arroyo. An island situated between Flores and the mainland, used only a few years ago as a park by the inhabitants of Flores, was now almost completely submerged. This, to the collector, constitutes a decidedly unfavorable condition, because the one feature most desired is an opportunity to work with the water at its lowest possible stage. Yet, in spite of the present high water, a number of species of fresh-water shells were found.

Along a low, gently sloping, grassy shore, the following species were taken:

<i>Drepanotrema cultratus</i>	<i>Amnicola petenensis</i>
<i>Drepanotrema isabel</i>	<i>Gundlachia hjalmarsoni</i>
<i>Aplexa cisternina</i>	<i>Gyraulus liebmanni</i>
<i>Tropicorbis obstructus</i>	<i>Gyraulus petenensis</i>
<i>Tropicorbis obstructus anodontus</i>	<i>Pomacea flagellata</i>
<i>Ferrissia excentrica</i>	<i>Eupera singleyi</i>
<i>Potamopyrgus coronatus</i>	<i>Physa squalida</i>

In the flooded, muddy-bottomed arroyo at Pueblo Nuevo, the following forms occurred:

<i>Pomacea flagellata</i>	<i>Eupera singleyi</i>
<i>Gyraulus liebmanni</i>	<i>Leptodea paludosa</i>
<i>Tropicorbis obstructus anodontus</i>	<i>Physa squalida</i>
<i>Amnicola petenensis</i>	

Dr. L. C. Stuart, who visited Ramate, at the east end of Lake Petén, in 1934 brought back several species which were in a semi-fossil state, notably *Paludestrina exigua* and *Cochliopa infundibulum*. An unsuccessful effort was made by the present expedition to find these alive. This is apparently a situation which parallels that of Pyramid Lake in Nevada, where huge windrows of snails occur on former beaches high above the present lake level, but none of them could be found alive in the lake when a search was made for them in 1934. In both instances we are evidently observing the transition of a group which is passing from the recent to the fossil state.

All of the smaller lakes showed signs of a rise in water level. On the whole they were less productive than Lake Petén, although the species found in them were essentially like those of Lake Petén.

3. Arroyos

The arroyos or creeks in Guatemala were not much different from those elsewhere. Those flowing into Lake Petén were for the most part flooded,

and where there was sufficient water throughout the dry season they yielded approximately the same species that one finds along the lake shore. Those tributary to the rivers were clear in the dry season and flowed in some cases over a sand or gravel bottom and in others over rock ledges or boulders. In the rainy season such streams are probably torrents. They usually contained species characteristic of the drainage to which they belong. A tributary of Río San Pedro, about one-half mile north of Laguna Yalac, had the following species:

<i>Amnicola petenensis</i>	<i>Tropicorbis obstructus</i>
<i>Potamopyrgus coronatus</i>	<i>Tropicorbis obstructus anodontus</i>
<i>Gundlachia hjalmarsoni</i>	<i>Pomacea flagellata</i>
<i>Ferrissia excentrica</i>	<i>Aplexa cisternina</i>
<i>Ferrissia aguadae</i>	

To the above list we could add: *Amnicola guatemalensis*, *Eupera singleyi*, and *Pachychilus corvinus*, which were found in Arroyo Xotal, another tributary to this same river.

From a small arroyo tributary to Río de la Pasión, east of Sebol in Alta Vera Paz, the following species were taken:

<i>Amnicola guatemalensis</i>	<i>Somatogyrus clenchi</i>
<i>Amnicola pasionensis</i>	<i>Aplexa cisternina</i>
<i>Cochliopa francesae</i>	<i>Pachychilus pilsbryi</i>

Most of the arroyos tributary to rivers contain *Pachychilus*. In Arroyo Yalchactilá of Río de la Pasión drainage some of the largest *Pachychilus* taken by the expedition were found. They were living on and among the dead leaves which covered the bottom of the stream.

4. Rivers

The expedition collected mainly from two rivers: the Río San Pedro in the northern part of Petén, and the Río de la Pasión with its tributaries in southern Petén and northern Alta Vera Paz. Both of these streams belong to the Río Usumacinta drainage.

The San Pedro was more or less lakelike in character in the region of El Paso de los Caballos. It continued as such downstream for some sixty miles to Mactún, where it narrows and forms what is known as the Mactún Rapids. The river yields very little to the shell collector. From dead leaves, bits of woods, etc., accumulations along shore at El Paso de los Caballos, the following species were taken:

<i>Potamopyrgus coronatus</i>	<i>Cochliopa infundibulum</i>
<i>Tropicorbis obstructus anodontus</i>	<i>Ferrissia excentrica</i>
<i>Eupera singleyi</i>	<i>Aplexa cisternina</i>
<i>Amnicola guatemalensis</i>	<i>Pomacea flagellata</i>

The Río San Pedro assumes the character of a creek as it approaches Laguna Yalac above El Paso de los Caballos. In this stretch of about six miles, mussels were found, particularly *Leptodea paludosa* and *Psoronaias semi-granosus*.

The Río de la Pasión was by far the largest stream visited by the present expedition. Some seventy-five miles of its headwaters, from the region of La Ceiba to Tres Islas, contained approximately as many rapids. The region below Tres Islas on downstream through Sayaxché was deep and wide, and the rate of flow was decidedly sluggish. The molluscan fauna of the Río de la Pasión was quite characteristic, and a number of species were restricted to it. In the headwaters the following forms were found:

<i>Amnicola pasionensis</i>	<i>Ferrissia excentrica</i>
<i>Amnicola guatemalensis</i>	<i>Aplexa cisternina</i>
<i>Cochliopa francesae</i>	<i>Pomacea flagellata</i>
<i>Somatogyrus clenchi</i>	<i>Pachychilus pilsbryi</i>

The occurrence of the *Amnicola*, *Aplexa*, *Cochliopa*, *Somatogyrus*, and *Ferrissia* was found to be restricted. Most of these were taken from the lower surfaces of dead leaves which had accumulated in quiet pools near shore. Seldom could any of these be found in the current away from shore. *Pachychilus pilsbryi* was found invariably between stones on sand and gravel in the current, as well as in the more quiet pools near shore. Mussels did not occur in the headwaters of the Pasión.

In its lower reaches, within the region of Sayaxché, the following species were collected:

<i>Amnicola petenensis</i>	<i>Cochliopa francesae</i>
<i>Amnicola pasionensis</i>	<i>Ferrissia excentrica</i>
<i>Somatogyrus clenchi</i>	<i>Eupera singleyi</i>

These were found largely on the lower surfaces of stones in pools near shore.

ZOOGEOGRAPHICAL RELATIONS

The examination of the molluscan material has shown that the three explored areas of Petén and Alta Vera Paz—to be spoken of hereafter as the central, northern, and southern areas or regions—are also faunal areas. Each has species which do not occur in the other two areas. Certain species occur in two of the areas, but not the third. The barriers in the way of a more general distribution are plainly enough ecological in some instances. In others, the barriers appear to be geographical, involving such complex factors as soils, rocks, means of dispersal or transport, food, humidity, temperature, shelter, and physiological adaptability. The following lists of species demonstrate the faunal divisions:

Exclusively Central

<i>Euglandina cylindracea</i>	<i>Helicina rostrata</i>
<i>Praticolella griseola</i>	<i>Gyraulus petenensis</i>
<i>Brachypodella speluncae</i>	<i>Drepanotrema isabel</i>
<i>Drymaeus tropicalis</i>	<i>Physa squalida</i>
<i>Opeas micra</i>	<i>Aplexa impluviata laeta</i>
<i>Succinea carmenensis</i>	<i>Paludestrina exigua</i>
<i>Chondropoma rubicundum</i>	<i>Pachychilus corvinus indifferens</i>

Exclusively Northern

<i>Streptostyla nigricans</i>	<i>Succinea guatemalensis</i>
<i>Streptostyla ligulata</i>	<i>Choanopoma gaigei</i>
<i>Guppya pittieri</i>	<i>Helicina flavida</i>
<i>Leptinaria stolli</i>	<i>Nephronaias calamitarum</i>
<i>Sterkia eyriesii</i>	<i>Plagiola nicaraquensis</i>

Exclusively Southern

<i>Drymaeus sulphureus</i>	<i>Cochliopa guatemalensis</i>
<i>Leptinaria filicostata</i>	<i>Pachychilus glaphyrus lacustris</i>
<i>Megalomastoma simulacrum</i>	<i>Pachychilus indiorum</i>
<i>Helisoma tenuis</i>	<i>Pachychilus pilsbryi</i>
<i>Amnicola pasionensis</i>	<i>Amblyema digitata</i>
<i>Cochliopa francesae</i>	<i>Plagiola sallei</i>
<i>Somatogyrus clenchi</i>	<i>Pisidium singleyi</i>

Central and Northern Only

<i>Averellia suturalis</i>	<i>Helicina arenicola</i>
<i>Microceramus concisus</i>	<i>Tropicorbis obstructus</i>
<i>Pupisoma dioscoricola</i>	<i>Drepanotrema cultratus</i>
<i>Choanopoma radiosum</i>	<i>Cochliopa infundibulum</i>
<i>Gastrocopta servilis</i>	<i>Pachychilus corvinus</i>
<i>Amnicola guatemalensis</i>	<i>Psoronaias semigranosus</i>

Central and Southern Only

<i>Microconus wilhelmi</i>	<i>Bothriopupa leucodon</i>
<i>Gastrocopta pentodon</i>	<i>Pachychilus glaphyrus</i>

More intensive collecting, particularly in the wet seasons, is likely to alter these lists. Nevertheless, it appears certain that numbers of the species will be found in the end to be confined to a single one of the three areas. The country of the central lakes has been isolated geologically from exterior drainage so long that this independence or detachment is bound to be reflected in some degree in the character of the molluscan fauna. The region of the upper Río de la Pasión where it was visited is an outlier of the high uplands of Alta Vera Paz. Like most mountainous limestone districts, Alta Vera Paz has acquired a fauna a large part of which is peculiar to itself.

Such more or less endemic mollusks can scarcely be expected to occur also in the vicinity of Lake Petén or in even higher parts bordering the Río San Pedro.

As regards the fresh-water mollusca, it is to be understood that the species of the northern and southern areas are intimately related to, and sometimes identical with, those of the lower Río Usumacinta system. Some of the species taken by the expedition occur as well in waters of the Department of Izabal in eastern Guatemala. Part of these species may have been distributed overland. Part may represent parallel development. In the case of the genus *Pachychilus*, these identities possibly point to ancient drainage connections that have disappeared.

In 1890–1901 Professor Eduard von Martens brought together for the *Biologia Centrali-Americana* all the then available information on the mollusks of Guatemala. He accredits fifteen species to the Petén–north Alta Vera Paz regions which were not found by the expedition of 1935. These species are:

<i>Zonitoides arboreus</i>	<i>Opeas gladiolus</i>
<i>Thysanophora turbinella</i>	<i>Subulina octona</i>
<i>Drymaeus lilacinus</i>	<i>Pseudosubulina lirifera</i>
<i>Drymaeus maculatus</i>	<i>Planorbis wyldi</i>
<i>Simpulopsis simula</i>	<i>Menetus belizensis</i>
<i>Coelocentrum anomalum</i>	<i>Pachychilus graphium</i>
<i>Coelocentrum fistulare</i>	<i>Hemisinus ruginosus</i>
<i>Holospira subtilis</i>	

The first two of the species were possibly overlooked in 1935 because of their small size although other shells, still smaller and hitherto unreported, were found. The last two are cited as from Lake Petén. They may be destroyed by the recent high-water levels. *Subulina octona* is a common mollusk of the New World tropics, but was seen by the expedition only at Puerto Barrios.

Besides the new species later to be described in this paper, the expedition collected the following species which are not assigned by von Martens to the areas explored in 1935:

<i>Salasiella margaritacea</i>	<i>Caecilioides consobrina</i>
<i>Guppya pittieri</i>	<i>veracruzensis</i>
<i>Hawaiiia minuscula</i>	<i>Leptinaria martensi</i>
<i>Microconus wilhelmi</i>	<i>Leptinaria stollii</i>
<i>Thysanophora impura</i>	<i>Leptinaria filicostata</i>
<i>Thysanophora plagiopycha</i>	<i>Bothriopupa leucodon</i>
<i>Chanomphala pilsbryi</i>	<i>Gastrocopta pentodon</i>
<i>Polygyra yucatanica</i>	<i>Gastrocopta servilis</i>
<i>Drymaeus tropicalis</i>	<i>Pupisoma eyriesii</i>
<i>Drymaeus shattucki</i>	<i>Carychium exiguum mexicanum</i>

Choanopoma gaigei
Helicina arenicola
Helisoma tenuis
Gyraulus orbiculus

Tropicorbis obstructus
Gundlachia hjalmarsoni
Cochliopa guatemalensis
Potamopyrgus coronatus

In addition, all of the succineas which were collected by the expedition appear to be reported for the first time, although these shells, greatly varied and to a great extent lacking in definite characters, may be in the earlier publications under other names.

Mr. A. A. Hinkley made three collecting trips to Guatemala about 1918. He explored the country from Livingston on the eastern seaboard to Lake Amatitlán near Guatemala City. Sixteen terrestrial species which he has mentioned (1920) as from the uplands drained by the Río Cavech were not seen in the Petén-Alta Vera Paz regions. It would seem that the genera of fresh-water shells taken by Hinkley and those collected in 1935 are much the same for the two general regions, but many of the species are different. The three fresh-water clams of Hinkley's lists, for example, are not among those of Petén-north Alta Vera Paz.

Bequaert and Clench (1933 and 1936) have made two special studies of the mollusca of Yucatan in connection with the Carnegie Institution explorations. They have compiled all the names of terrestrial and fresh-water species which have been accredited to the State besides passing critically on Yucatan material which came to their hands. Since Petén abuts upon the Yucatan Peninsula, the two regions have certain species in common. The main differences are geographical. Yucatan, for illustration, has certain coastal species some of which range from Florida through Mexico. It lacks, on the other hand, species peculiar to lakes and running surface waters. We have here set down those species of Yucatan which were seen by Bequaert and Clench and which would appear to be absent from the Petén-north Alta Vera Paz regions of Guatemala.

Euglandina carminensis
Streptostyla ventricosula
Spiraxis maya
Thysanophora coecoides
Drymaeus sepeastrum
Drymaeus dominicus
Zachrysia auricoma havanensis
 (introduced)
Bothriopupa variolosa
Succinea avara
Helisoma caribaens
Tropicorbis maya

Drepanotrema lucidum
Aplexa princeps
Aplexa maugeriae
Aplexa spiculata
Aplexa spiculata gracilis
Aplexa spiculata abbreviata
Ferrissia sallei
Choanopoma largillierti
Pomacea yucatanensis
Cochliopa hinkleyi
Sphaerium subtransversum

THE MOLLUSCAN FAUNA

Family Oleacinidae

Pseudosubulina sp.

This, the only representative of the genus taken by the expedition, was a single specimen, broken and specifically unrecognizable. It was collected four miles southwest of La Ceiba, Alta Vera Paz.

Spiraxis alvaradoi, n. sp.

(Plate I, Fig. 1)

SHELL.—Small, elongate, cylindrico-conic, thin, pearly white. Whorls six, shouldered, somewhat flattened in the center. Embryonic shell smooth, shining, of about one and one-half whorls in size, the summit planospiral. The first post-embryonic whorl is sculptured with closely-set, vertical plicae, which increase in size with the shell's growth and become more widely separated. They are uniform in thickness at top and base. Between these plicae are fine, granular growth lines, crossed by very delicate revolving striae. Sutures deeply impressed. Last whorl twice as large as penultimate whorl, a little flattened, bluntly rounded at the periphery. Aperture entire, acute at top, broadly rounded at the base. Columella folded, not prominent. There is a slight notch behind the fold. Outer lip acute.

Holotype in Mus. Zool. Univ. Mich. Type locality: Limestone knoll five miles north of El Paso de los Caballos, Petén, Guatemala. Taken March 14, 1935.

	Measurements in mm.		
	Altitude	Diameter	Aperture altitude
Holotype	3.69	1.29	1.12
Paratype	3.82	1.32	1.13

Other specimens of about the same size vary a little from the holotype in the number of whorls, the extreme being six and one-half. This species is probably closest to *S. maya* Bequaert and Clench, 1933. Dr. H. A. Pilsbry, who has examined the material, directs attention to the fact that although the number of whorls of *alvaradoi* is fewer than in *maya* they increase more rapidly. He reports that a bleached specimen of the former species was taken by A. A. Hinkley at Livingston, Guatemala, to the southeast of the region explored in 1935. The new shell is named for Señor Rubén Alvarado of Flores to whom the expedition owes much for many courtesies and unsolicited kindnesses. *S. alvaradoi* was found to occur at four stations of the central area, five of the northern, and one of the southern.

Spiraxis funibus, n. sp.

(Plate I, Fig. 2)

SHELL.—Very small, thin, nearly cylindrical, translucent. Texture silken, color white and shining. Whorls four and one-half, very loosely coiled,

shouldered and yet more rounded than in *S. alvaradoi*. Sutures much impressed, conforming to the loose coiling. Embryonic shell one and one-half whorls, on the same plane; the surface appearing granular or pitted when examined under thirty magnifications. Post-embryonic sculpture consists of rather crowded vertical plicae which are of uniform thickness suture to suture; crossed by distinct revolving striae that give a latticed effect to the whole. These striae are especially prominent in the interpiculate spaces which have no other sculpture except very delicate growth lines. Body whorl about twice as large as the penultimate whorl, broadly rounded and showing no sign of keel. Aperture pinched at top, widely rounded at base and a little produced. Columella rather short, folded as in *Lymnaea*, slightly notched behind. Outer lip acute, unthickened.

Holotype in Mus. Zool. Univ. Mich. Type locality: Limestone knoll five miles north of El Paso de los Caballos, Petén, Guatemala. Taken March 14, 1935.

	Measurements in mm.		
	Altitude	Diameter	Aperture altitude
Holotype	2.05	.76	.65
Paratype	2.50	.82	.72

The specific distinction of this mollusk has been pointed out by Dr. Pilsbry. Variation is mostly restricted to size and number of whorls, although these do not exceed five and one-half in any case among the shells examined. In a lot collected east of El Paso de los Caballos were three atypical specimens whose whorls were convex, scarcely shouldered. Others of the lot were of the usual form. The revolving striae are conspicuous in fresh individuals, but are subject to obscuration through wear in adults. This species appeared at some localities in association with *S. alvaradoi*, but not everywhere that that shell occurred. The name has been chosen because of the marked resemblance that the shell has under the glass to a twisted cord. *S. funibus* was collected at three stations of the central, four of the northern, and one of the southern areas.

Streptostyla meridana (Morelet) 1849

Common in the central and northern regions, but taken at only one place in the southern area.

Streptostyla nigricans (Pfeiffer) 1845

Taken at three localities of the El Paso de los Caballos vicinity, but not found elsewhere.

Streptostyla ligulata (Morelet) 1849

Found in small numbers in two localities near El Paso de los Caballos of the northern area.

Salasiella margaritacea (Pfeiffer) 1856

Taken at twenty-two localities in all, ten of the central region, nine of the northern, and three of the southern. Two specimens were collected that had small denticles on the columellae, which were apparently adventitious.

Euglandina cumingi (Beck) 1837

A number of species of the general configuration of *E. cumingi* have been described, and it is possible that more than one species has here been brought under the one name. A certain amount of variation was found in shape and proportions while the sculpture remained constant. To the writers no differences seemed sufficient to warrant specific distinction. Shells of a peculiarly greenish hue were taken at Sayaxché, but nowhere else. The mollusk occurred at forty-one stations in Petén and Alta Vera Paz.

Euglandina cylindracea (Phillips) 1846

Taken at twelve places none of which were more than four or five miles distant from Lake Petén. The plicate sculpture which begins immediately after the embryonic whorls is one point of distinction from the preceding species.

Family Zonitidae

Guppya gundlachi (Pfeiffer) 1840

Found in six localities of the central area, five of the northern, and two of the southern. Only three specimens appeared in the Guatemalan collections which could be assigned to the form *orosiana* von Martens, 1892. They were from the south shore of Laguna de Eckibix about twenty-five miles south of Flores, the banks of the Río San Pedro at El Paso de los Caballos and again five miles north of this village.

Guppya pittieri von Martens 1892

Three specimens were taken on the banks of the Río San Pedro at El Paso de los Caballos. The species was seen nowhere else. The shells agree with a specimen which was collected by Dr. H. B. Baker near Lake Catemaco, Mexico.

Habroconus trochulinus (Morelet) 1851

Not uncommon although in small colonies. Collected in four localities of the central area, five of the northern, and two of the southern.

Hawaiiia minuscula (Binney) 1840

Collected in seventeen localities, six of which were of the central region, eight of the northern, and three of the southern. The subspecies *permodesta* (Strebel and Pfeffer) 1880 occurred with the typical form at two stations

of the central area, three of the northern, and two of the southern, seven localities in all. At least in this part of Central America, the subspecies can scarcely be considered of more significance than a forma.

Family Endodontidae

Chanomphala pilsbryi H. B. Baker 1922

Eleven lots in all, four from the central area, five from the northern, and two from the southern. In addition to the strong costate sculpture, the genus has a beautiful lattice-like ornamentation which is intercostate and can be made out only under the compound microscope.

Family Sagdidae

Microconus wilhelmi (Pfeiffer) 1866

Rare. Taken once in the central region and once in the southern.

Thysanophora impura (Pfeiffer) 1866

Found at two stations of the central area, two of the northern, and one of the southern. All five localities are in the vicinity of standing or running water.

Thysanophora conspurcatella (Morelet) 1851

Readily distinguished from *T. impura* by the greater altitude, narrower umbilicus, and finer texture. Nor has the species the practice of covering its shell with dirt as has *impura*. It is also a shell of the uplands rather than of the lowlands. Four lots were taken in the central area, four in the northern, and none in the southern.

Thysanophora plagiptycha (Shuttleworth) 1854

Of little variation. Collected in seven localities of the central region, six of the northern, and two of the southern.

Xenodiscula taintori, n. sp.

(Plate I, Figs. 5, 5a, 5b)

SHELL.—Very small, nautiloid, nearly transparent, pearly white, and shining. Spire slightly raised, umbilicus wide and showing all whorls. Whorls two and one-half, rounded, the first one of very rapid growth. The sculpture consists of irregularly spaced incised lines which represent rest periods. These lines are most closely crowded together at the beginning of post-embryonic life and at the approach of maturity. In brief, growth has been greatest during the middle period. Very fine growth lines can be made out between the indented lines by high magnification. The aperture is broadly elliptical, somewhat deflected. On the parietal wall is a single lamella which is slightly angled upward. It extends into the aperture only a short distance. The outer lip is acute, unthickened.

Holotype in Mus. Zool. Univ. Mich. Type locality: Woodland just east of El Paso de los Caballos, Petén, Guatemala.

	Measurements in mm.	
	Altitude	Diameter
Holotype56	1.62
Paratype50	1.24

This shell is smaller and its sculpture more delicate than in the only other known species of the genus, *X. venezuelensis* Pilsbry 1920. It has also only one parietal tooth and none on the peripheral wall. The lamella appears in young specimens and is, therefore, partially absorbed as growth proceeds. The shell was taken in four localities of the central area, seven of the northern, and two of the southern. The genus *Xenodiscula* has been placed in the family Sagdidae on shell characters. The position may be changed, of course, when the opportunity is provided for anatomical examination. *X. taintori* was taken at twelve localities in Petén and at one in Alta Vera Paz.

Family Polygyridae

Polygyra yucatanea (Morelet) 1849

Taken in eight localities of the central area, two of the northern area, and four of the southern. No member of the genus has been reported hitherto from Guatemala so far as the writers can learn. It is strange that the species should have been overlooked by Morelet during his time at Flores since the shell is common in the vicinity. *H. helictomphala* Pfeiffer 1856 rests on slight modifications of the external tooth of *yucatanea*. Such examples appeared with typical forms in material collected at El Paso de los Caballos and again at a locality on the north shore of Laguna Perdida.

Praticolella griseola (Pfeiffer) 1841

From the present collections this species seems commonest in North Guatemala in open places on the shores of Lake Petén near Flores. It was discovered at five localities of the central area and nowhere outside of this section. Von Martens combines this species with *P. berlandieriana* (Moricand) 1836. Pilsbry and Ferriss (1906) point out that the latter shell frequently has "a short lamellar tooth or callus on the parietal wall near the suture." No such feature appeared among the Guatemalan specimens.

Family Fruticicolidae

Averellia coactiliata (Deshayes) 1839

Collected at seventeen stations in the central area, ten in the northern, and seven in the southern. It was not taken by Morelet although at present it is common at Flores and in the vicinity.

Averellia suturalis (Pfeiffer) 1846

Rarer than the above species. It appeared at four collecting localities of the central region and seven of the northern. It was not seen in the southern area. Morelet's specimens were taken at San Luis, Petén. Banded specimens are very nearly absent from all lots. Young specimens are very hirsute, the hairs following the margins of the vertical growth lines.

Family Urocoptidae

Brachypodella speluncae (Pfeiffer) 1852

Morelet collected this species from the walls of a cave south of Flores. The present expedition found dead shells on the floor of the cave, and doubtless the living mollusks still inhabit the spot even if perhaps in smaller numbers. Taken in six other localities of the central area, but neither in the northern nor in the southern region.

Microceramus concisus (Morelet) 1849

Found to occur in seven localities of the central and two of the northern areas. The species is spoken of by Bequaert and Clench as "one of the few common shells of Yucatan." It was taken at Chama, Alta Vera Paz, Guatemala, by Hinkley.

Family Bulimulidae

Bulimulus unicolor (Sowerby) 1833

A variable species in North Guatemala in point of size, shape, and color. Young shells are frequently reddish brown. This color lightens with age so that half-grown shells may be partly brown, partly gray; mature shells are very nearly white. Ventricose specimens were found to occur both as distinct colonies and mingled with elongate forms. Two scalariform shells were collected. The species was taken at twelve stations of the central area, seven of the northern, and three of the southern. With the mollusks before us, it is obvious that they are all biologically identical in spite of their remarkable variability.

Drymaeus tropicalis (Morelet) 1849

A sinistral mollusk, collected at five localities of the central area. Bequaert and Clench (1933) point out that their *D. shattucki* has all the characteristics of *tropicalis* with the exception of sinistrality. The present expedition collected *tropicalis* at three stations where the species ran true and in three colonies in which there were mixtures with *shattucki*.

Drymaeus shattucki Bequaert and Clench 1933

Almost a camp-follower of human cultural enterprise. It was found in nine localities of the most completely cultivated central region, in five of

the northern that is less cultivated, and in two of the relatively wild southern area.

Drymaeus sulphureus (Pfeiffer) 1856

Taken in sparing numbers at two localities of the southern area.

Oxystyla princeps (Broderip) 1833

This is the largest of the land shells of Petén and possibly of Alta Vera Paz. Variation is small in North Guatemala, nor is it pronounced in other parts of the range of the species, the differences being mainly in color patterns. *O. princeps* occurred in nine localities of the central area, in nine of the northern, and in two of the southern. Collected also at Uaxactún by Van Tyne and Murie in 1931.

Family Ferussaciidae

Caecilioides consobrina veracruzensis Crosse and Fischer 1877

A very minute shell that is exceedingly common in a few places. It was taken at seven stations of the central, seven of the northern, and two of the southern areas.

Family Subulinidae

Subulina octona Bruguière 1792

Found by the expedition only at Puerto Barrios, Izabal, Guatemala.

Leptinaria martensi (Pfeiffer) 1856

This species was collected in sixteen localities of the central area, twelve of the northern, and nine of the southern. It is of variable form and sculpture. Occasionally, specimens resemble *L. mexicana* (Pfeiffer) 1866, in shape, but are otherwise like *martensi* typical. The eggs are very large in proportion to the size of the shell and in two or three individuals can be seen through the transparent shell substance.

Leptinaria elisae (Tristram) 1861

Occurs sometimes with the foregoing species. It was found at ten stations of the central area, five of the northern, and seven of the southern.

Leptinaria filicostata (Strebel) 1882

Very distinct. Rare. Seen at only two localities, both of which were in the southern region.

Leptinaria stolli von Martens 1898

Two specimens from the northeast shore of Laguna Perdida in the northern area are recognizable as this species. It is like *L. elisae* in shape, but lacks the parietal tooth.

Leptinaria, sp. indeter.

The material consists of four specimens from three localities, two of the northern area and one of the southern. The shells are very small, conic, the whorls very much rounded. They may be the young of a known species or mature examples of a form still undescribed. A new designation is not felt to be warranted.

Opeas gracile (Hutton) 1834

An introduced species that has adapted itself to cultivated districts throughout the tropics. The expedition collected it in numbers in fourteen localities of the central area, nine of the northern, and three of the southern—the populations show a relationship to human cultural enterprise.

Opeas micra (D'Orbigny) 1835

Taken in small numbers at three stations of the central area.

Opeas beckianum (Pfeiffer) 1846

Easily distinguished from the aforementioned species. It occurred at three localities of the southern region.

Family Pupillidae

Gastrocopta pentodon (Say) 1821

Rare. Taken in one locality of the central and one of the southern areas.

Gastrocopta servilis (Gould) 1843

Found in only two localities, one of the northern area and one of the southern. Specimens were commonest on the shores of the Río San Pedro at El Paso de los Caballos.

Bothriopupa leucodon (Morelet) 1851

Taken in small numbers at one station of the central area and one of the southern.

Pupisoma dioscoricola (C. B. Adams) 1845

Found at two places of the central region and five of the northern.

Sterkia eyriesii (Drouet) 1859

Collected at two localities of the northern area, and there only.

Family Auriculidae

Carychium exiguum mexicanum Pilsbry 1891

At one station of the central region, six of the northern, and two of the southern. Of little variation.

Family Succineidae

Succinea carmenensis Fischer and Crosse 1878

A single specimen which was taken in the central area is the same as shells from Yucatan which have been passed upon by Bequaert and Clench.

Succinea luteola Gould 1848

Found at one station of the central area, one of the northern, and one of the southern. Almost exactly like specimens of the species from Florida.

Succinea guatemalensis Morelet 1849

In the northern area at only one collecting station.

Succinea virgata microspira Fischer and Crosse 1878

Taken twice in the central area, once in the northern, and three times in the southern.

Family Veronicellidae

Veronicella moreleti (Crosse and Fischer) 1872

All specimens collected by the expedition were in the central area. Slugs proved to be rare, possibly because of the dryness of the season.

Family Cyclophoridae

Poteria dysoni (Pfeiffer) 1851

Although not taken at Flores by Morelet, this species proved to be a common one to the present expedition, and particularly so in the central area. It was collected in nineteen localities of this region, twelve of the northern, and four of the southern.

Megalomastoma simulacrum (Morelet) 1849

A peculiar shell that, at least in the regions covered by the expedition, must be considered rare. The species was collected in a woodland near Arroyo Yalchatilá, Alta Vera Paz, and again in the drift of the Río Pasión at El Cambio, Petén, both localities being in the southern area.

Family Pomatiasidae

Chondropoma rubicundum (Morelet) 1849

Numerous in individuals at the five stations of the central area where it was found.

Choanopoma radiosum (Morelet) 1849

Collected at five localities of the central area and one of the northern.

Choanopoma gaigei Bequaert and Clench 1933

This species was first taken at Chichén Itzá in Yucatan. In Petén it was found at two localities of the northern area.

Family Helicinidae

Helicina amoena (Pfeiffer) 1845

This species whose colonies are frequently populous in Guatemala was taken at sixteen stations of the central area, fifteen of the northern, and ten of the southern. *H. purpurea-flava* Morelet 1849 may be considered a form of *H. amoena*, and possibly a geographical subspecies. It is somewhat smaller and is more brightly colored than the typical mollusk. It appeared in the southern area in the vicinity of the headwaters of the Río Pasión.

Helicina rostrata Morelet 1851

Particularly distinguished by an extension of the peripheral keel into a blunt protuberance. Morelet's specimens were taken in Alta Vera Paz, those of the present expedition at the top of a limestone knoll one and one-quarter miles south of Flores of the central area.

Helicina tenuis Pfeiffer 1848

Collected in twelve localities of the central area, six of the northern, and eight of the southern. As in the case of *H. amoena*, the shells of the southern region are of a brighter color than those of the other two areas and are a little smaller.

Helicina oweniana Pfeiffer 1848

One of the most common of the mollusks taken. It was found at nineteen localities of the central area, thirteen of the northern, and eight of the southern. The red-lipped variety, *coccinostoma* Morelet 1849, was collected in one area on the banks of the Río de la Pasión. The species is variously colored from shining white to dark brown. Numerous specimens have color bands just above the periphery. Where more than fifty examples were taken, counts were made of the banded and nonbanded shells. In all instances, the nonbanded outnumbered the banded. The latter at one locality were as low as 5.7 per cent of the whole, and at another, as high as 36.6 per cent. The largest lot numbered 140. It was from a knoll three kilometers south of Pueblo Nuevo, not far from Flores. The nonbanded were 79 per cent, the banded 21 per cent. This is probably a representative colony.

Helicina arenicola Morelet 1849

Not common. Seen only at three stations of the central area and two of the northern.

Helicina flavida Menke 1828

Found only in the northern area, and there in five localities.

Lucidella lirata (Pfeiffer) 1847

Not reported hitherto from Petén. It was collected at seventeen stations of the central region, thirteen of the northern, and eleven of the southern. In certain lots, the revolving costae are carried beyond the outer lip, giving the feature a rough, almost nodular appearance.

Pyrgodomus microdina (Morelet) 1851

Morelet's specimens were found in Alta Vera Paz. The present expedition collected it at five places of the central area, one of the northern, and one of the southern. As the shell is small and the mollusk has the practice of covering its shell with dirt, it is easily overlooked.

Family Planorbidae

Helisoma tenuis (Dunker) 1850

The only locality for this species is the Arroyo Subín, near Santa Teresa, Petén. This is at the border of the central and southern areas.

Gyraulus liebmanni (Dunker) 1850

Found at three stations of the southern area.

Gyraulus orbiculus (Morelet) 1837

Taken at one station each of the central, northern, and southern areas.

Gyraulus aeruginosus (Morelet) 1851

This shell was fairly abundant in the drift collected at the outlet of Lake Amatitlán, near Guatemala City.

Gyraulus petenensis (Morelet) 1851

Apparently confined to the central area in which it was collected at four localities.

Drepanotrema cultratus (D'Orbigny) 1845

Quite abundant where found. This was at two stations of the central area and one of the northern.

Drepanotrema isabel (Reeve) 1877

A distinctive shell, varying little. It was found in three localities of the central area.

Tropicorbis obstructus (Morelet) 1849

The typical mollusk has internal lamellae. A form occurs in which this character is lacking. It was named *anodontus* by Pilsbry in 1920. A collection of seventy shells from one shore of Lake Petén was made up of ten

examples of the typical form and sixty of *anodontus*. At another locality on the lake a lot of about one hundred specimens consisted wholly of *anodontus*. The material, 118 specimens of *obstructus* and twenty-five of *anodontus*, was obtained from a drying *aguada* southwest of San Benito. The two forms, considered as one species, occurred in eight localities of the central area, in two of the northern, and in none of those of the southern region.

Family Physidae

Aplexa cisternina (Morelet) 1851

Reported hitherto as from Yucatan, but not from North Guatemala. It was taken by the expedition at seven localities of the central area, four of the northern, and six of the southern. The species also inhabits the outlet of Lake Amatitlán.

Aplexa impluviata (Morelet) 1849

New to the records of the mollusca of Petén. The shells were found in quantity in a small *aguada* southwest of San Benito, Petén. Another locality for the species is the Río Michatoya, near Palín, Amatitlán, Guatemala.

Physa squalida Morelet 1851

This species was collected by Morelet in swamps of the Río Usumacinta, Tabasco, Mexico. The expedition found it at two localities of the central area, Petén.

Physa polakowskii Clessin 1886

The only place where this species was taken was in the Río Guacalate, between Mixtán and Santa María, Escuintla.

Family Ancyliidae

Ferrissia (*Laevapex*) *excentrica* (Morelet) 1851

Collected in eleven localities of the central area, six of the northern, and ten of the southern. It was also taken in the Río Guacalate, Esquintla, in the Pacific Ocean drainage. The mollusk is of wide range, having been reported from Texas on the north to Costa Rica.

Ferrissia (*Laevapex*) *aguadae*, n. sp.

(Plate I, Figs. 7-7a)

SHELL.—Oval, about half as high as broad, transparent, uniformly brown. Anterior and posterior margins broadly rounded, the central parts of the lateral margins nearly straight and parallel; anterior slope at a sharper angle than the posterior. All margins are slightly incurved beneath. Growth lines fine, irregularly spaced. The radial sculpture is bold, somewhat darker than the background of the shell; it extends from base of apex to the margins, the lines increasing in thickness with growth. Under high

power and by transmitted light, the whole sculpture is beautifully reticulate. Apex slightly anterior and not centered, being rather more to the left side than the right. Although showing faint growth lines, the apex is much smoother than is the rest of the shell surface. The interspaces of these lines resemble the sulci of the human fingers in their evenness. No punctations are observable.

The radula corresponds almost exactly to that of *Ferrissia fuscus* (C. B. Adams), which is the type of Walker's subgenus *Laevapex*. The medians are of the same size and character as in the associated *F. excentrica*, but the uncini are much smaller.

Measurements (in mm.) of holotype: Length 4.5, width 3.4, height 1.5.

Type locality: Aguada de Copó, one mile south of La Libertad, Petén, Guatemala. Holotype in Mus. Zool. Univ. Mich.

F. aguadae was taken in two localities of the central area, three of the northern, and two of the southern. There is little variation in the shells either within the colonies or as between colonies. A specimen which has been submerged in a solution of oxalic acid to remove extraneous deposits of the surface is of a somewhat lighter color than the holotype, and the radial sculpture is not so conspicuous. The rest periods are sharply defined as thickened portions of the periostracum. They numbered eight in this individual.

Gundlachia hjalmarsoni Pfeiffer 1858

This small shell was rather plentiful in one or two localities. It appeared, altogether, at five stations of the central area, three of the northern, and one of the southern. The apices of these specimens differed decidedly from those of *G. hinkleyi* Walker, which occurs in Amatitlán, Guatemala.

Family Ampullariidae

Pomacea flagellata (Say) 1827

The most widely distributed of all the fresh-water snails collected by the expedition. It was taken at nine localities of the central, eight of the northern, and fourteen of the southern areas. A number of subspecies have been erected upon differences in size, on the occurrence or nonoccurrence of malleations, on prominence of spire and so on. The material brought from Guatemala shows that some of these so-called subspecies are associated together in the same spot. It indicates that large forms will be in large bodies of water, Lakes Petén and Petenxil for example. At the other shell extreme is a small, tightly coiled, thickened mollusk with comparatively high spire. It was found in eight localities—four of which can be classified as small tributary streams, one as a head stream, one as a marsh, one as an *aguada*, and one as a lake. This lake was small and shallow.

Family Amnicolidae

Amnicola petenensis Morelet 1851

The largest species of the genus in the regions covered by the expedition. Taken in eight localities of the central area, one of the northern, and six of the southern.

Amnicola guatemalensis Fischer and Crosse 1894

Smaller than *A. petenensis*, but probably closely related to it. Collected at four localities of the northern region and ten of the southern. Not seen at any place in the central area.

Amnicola hyalina Morelet 1851

Found in great numbers in the outlet of Lake Amatitlán, near Guatemala City.

Amnicola pasionensis, n. sp.

(Plate I, Fig. 4)

SHELL.—Very small, elongate-conic, smooth, shining, greenish white, translucent. Whorls four, convex; sutures much impressed. Body whorl unflattened and about as large as the two previous whorls. Growth lines fine, regularly spaced, and crowded. Aperture ovate, rounded at the base, a little angulate at the top. Columella raised, not folded or thickened, and not joined to the parietal wall, a slight notch being left behind it. Outer lip a little incurved at the top and more or less so below the periphery.

Measurements of holotype: Altitude 1.74 mm., diameter .91 mm.

Type locality: Arroyo Subín, tributary to the Río de la Pasión, about two miles above Santa Teresa, Petén, Guatemala. Holotype in the Mus. Zool. Univ. Mich.

A. pasionensis is somewhat smaller and less conic than *A. floridana*, which it closely resembles in shell characters. Some of the specimens are a little shouldered on the body whorl and have a more rounded aperture than has the holotype. Occasional specimens are pinched in on the body whorl, making the aperture elliptical rather than ovate, and extending the base into a very small lip. The principal variation among all the shells seen is in the proportions of altitude to diameter. Under the glass this seems to be marked, but actually the variation is in hundredths of a millimeter. The species was collected at fifteen stations, all of which are in the Río de la Pasión or its tributary, the Arroyo Subín.

Paludestrina exigua (Morelet) 1851

It was so common as to form windrows in Lake Petén, all the shells being subfossil. Found in sparing numbers at two other localities of the central area.

Potamopyrgus coronatus (Pfeiffer) 1840

Taken at five localities of the central area, three of the northern, and one of the southern. Of 381 specimens collected in the outlet of Lake Amatitlán near Guatemala City, 360 were of the smooth form.

Somatogyrus clenchi, n. sp.

(Plate I, Fig. 6)

SHELL.—Broadly conic, thick, not greatly depressed, Calla-green.¹ Texture waxy. Whorls three and one-quarter, deeply sutured. Embryonic shell is about one whorl in size, very rapidly increasing. Under 150 magnifications, it shows the epidermal pits to which Walker directed attention. These pits do not follow any pattern. Body whorl ventricose, roundly shouldered, its growth lines being equidistant and very fine. At the shoulder are several microscopic, noncontinuous revolving lines, incised. Aperture very large for the shell, semicircular, not produced. The columella is broad, thickly calloused, flattened on the upper surface. It hugs the parietal wall closely so that the notch behind it is very small. The inner edge of the columella is slightly incurved. Outer lip thin-edged, retrorse.

Measurements of holotype: Altitude 5.00 mm., diameter 4.10 mm.

Type locality: Río de la Pasión, Sayaxché, Petén, Guatemala.

The species was found in twelve localities, all in the drainage basin of the Río de la Pasión. On the whole, there is little variation in shell characters among the several lots. The very young shells of about two whorls have the upright, unthickened columella of species of *Ammicola*. In some very old specimens the columella has so thick a deposit of callus that there is no umbilical niche. Individuals were observed which have the black, adventitious specks for which *Eupera maculata* Morelet was named. Geographically, *S. mexicanus* Pilsbry of the Coy River, northeastern Mexico, is the nearest related species. The measurements, 5.3 mm. altitude by 4.5 mm., seem not greatly different from those of *S. clenchi*, yet the shape of the shells is quite different. In searching for species most closely resembling this Guatemalan form, that which seemed nearest in the writers' opinion was an unusually depressed form of *S. subglobosa* (Say) from the vicinity of St. Louis, Missouri. This latter shell is, of course, much larger than *clenchi*.

The species proved to be ovoviviparous.

In essentials, the radula is that illustrated by Walker (1918: 32). The centrals are rather wider, and in addition to the usual upper dentition have two to three basal cusps, which are fewer than commonly figured for the genus. Laterals have one large cusp and five to six smaller cusps of equal size. Marginals are multicuspid, the inner one hooklike, the outer clavate.

Cochliopa infundibulum von Martens 1899

Exceedingly common in Lake Petén as a subfossil shell. Living examples were taken in Laguna de Eckibix, also in the central area. One specimen was found in drift of the Río San Pedro at El Paso de los Caballos of the northern region.

¹ Capitalized color name from R. Ridgway, *Color Standards and Color Nomenclature*, Washington: Published by the author, 1912. Pp. 1-44, 53 color plates.

Cochliopa francesae, n. sp.

(Plate I, Fig. 3)

SHELL.—Small, subglobose-conic, greenish gray, very much like a diminutive specimen of *Valvata tricarinata* (Say) in general appearance. Broadly umbilicate. Whorls three and one-half. The embryonic shell consists of one and one-half whorls, smooth, rapidly increasing. Post-embryonic sculpture is of revolving striae or ribs, of which about thirty show on the body whorl. Those above the periphery of this whorl are stouter than those below it. The strong striae at the top cause a decided shouldering. Aperture nearly round, the outer sculpture showing through. Columella thickened, raised so that the edge of it is parallel with the outer lip with which it is continuous. Outer lip a little less thickened than the columella. Two full whorls show within the umbilicus.

Measurements of holotype: Altitude 1.29 mm., diameter 2.24 mm.

Type locality: Río de la Pasión, at the mouth of Arroyo Chajchiníc, northwest of Porvenir, Alta Vera Paz, Guatemala. Holotype in Mus. Zool. Univ. Mich.

This species varies in height and in sculpture. Numbers of the shells are flatter than the holotype, being nearly planorboid. As in other species of the genus, there are high or loosely coiled individuals. These are more frequent in some of the lots than in others. In material from the Río de la Pasión at Sayaxché, twenty-three shells are striate, and eight are nonstriate. The ratio would appear to vary from colony to colony. The outer lip is slightly crenulate in young shells because of the projecting ribs. Very clean specimens show fine, silken, vertical growth lines under the glass. Some examples taken in the Arroyo Subín have deposits of coloring material in the ribs as in the case of *A. picta* Pilsbry. *C. francesae* was collected in sixteen localities, all of them in the Río de la Pasión or its tributaries. The species is named for Miss Frances Hubbs, daughter of Dr. Carl Hubbs, the senior member of the expedition.

The species is ovoviviparous. Three of the young were found in a specimen of *francesae*. They were smooth, planorboid. The whorls numbered about one and one-half, very rapidly increasing to a nearly circular aperture. The radula appears to be exceedingly small even for so small a shell. The one striking character is the basal denticles, which are about half the size of the middle cusps of the centrals.

Cochliopa guatemalensis (Morelet) 1851

Certain unsculptured and planospiral mollusks that were taken in two localities of the Arroyo Subín belonging to the drainage basin of the Río de la Pasión appear to be this species. Morelet's shells came from West Guatemala in the Pacific drainage.

Family Melaniidae

The family is represented in Central America by the genus *Pachychilus* which is obviously more closely related to *Potadoma* of Africa and *Brotia* of

eastern Asia than to the Pleuroceridae ranging from northeast Mexico into Canada. The shells taken in Guatemala fall into three well-defined groups which nowhere have been seen to overlap. Differentiating characters are shape, configuration of embryonic shell, development of sculpture, and, as between one group and the other two, the line of the outer lip. Texture is alike in two of these Guatemalan groups. The sculptural emphasis in one group is on the axial plicae, in another on the revolving striae. The third group is without other sculpture than that included under texture. The opercula are paleomelanian in all three.

The radulae of *Pachychilus* are long and narrow. The lingual ribbon from a specimen of *P. glaphyrus* was found to have a length of 36 mm.; one of the much smaller *P. pilsbryi*, a length of 23 mm. Laterals have five or six cusps mounted on a short peduncle. The toothed process of the inner marginal is sickle-shaped, and is suggestive of the acanthoglossate radular development in carnivorous gastropods. The outer marginal is short, clavate, and seldom has more than three unequal cusps. It is in the median teeth that differentiation is most marked between species. The margins of the basal plates, the embayment, platform, and rise lines show varying patterns which are distinctive in each species. For purposes of comparison, the centrals of all the Guatemalan species are here illustrated together with those of two species from Mexico. (Fig. 1.)

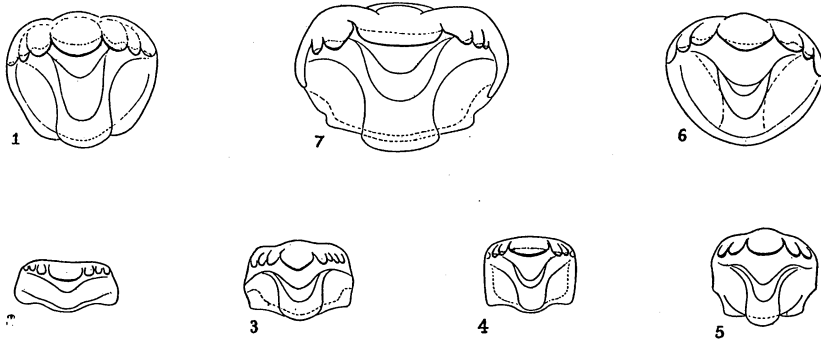


FIG. 1. Median teeth of the radulae of seven species of *Pachychilus*: 1, *indiorum*; 2, *vallesensis*; 3, *pleurostriatus*; 4, *pilsbryi*; 5, *corvinus*; 6, *largillierti*; 7, *glaphyrus*.

Pachychilus glaphyrus (Morelet) 1849

This is the heavy, elongate, more or less strongly sculptured shell whose variations are responsible for fully a dozen specific and subspecific names. Nearly all of these designations were recognizable among the 283 shells which were collected in the Arroyo Yalchactilá of the Río de la Pasión, about four miles southwest of La Ceiba, Alta Vera Paz. Revolving folds are on the bases of all the shells, and above the periphery of the body whorls of forty-one.

Only 125 have the conspicuous vertical plicae. This sculpture may consist of heavy or slight ridges, of rounded pustules or oblong nodes.

The eggs were found attached to dead leaves, which were abundant in the bottom of the arroyo. The leaves were in only a few inches of water on a mud-silt bottom near shore. The eggs occur in groups of three to five, are round and glassy in appearance, and are irregularly and linearly arranged as a single loosely attached layer. As might be expected in a species as large as *glaphyrus*, the eggs are also large, having a diameter of 3.9 mm.

Semifossil specimens of *glaphyrus* were collected on the shore of Lake Petén at Flores and at the most easterly island of Laguna de Eckixil. It was not determined whether the shells were native to the lakes, no living individuals being found there, or whether they were brought to these places as human food or bait for fishes. As the shells were like the strongly sculptured forms of the Arroyo Yalchactilá, an altogether different kind of habitat, the supposition is that they reached the lake beaches artificially.

Pachychilus glaphyrus lacustris (Morelet) 1849

Shells that correspond to descriptions and figures of this subspecies were taken in the Arroyo Subín, tributary to the Río de la Pasión. About half of 147 specimens show axial sculpture, but in only twelve are the plicae developed into nodes. All the material is striate on the bases. *P. g. lacustris* differs from *glaphyrus* in being more slender, in the prominence of sculpture where this is most strongly developed, and in the period or age at which sculpture begins. The Subín specimens have an index of obesity of 57.4 per cent as compared with 59.6 per cent in the case of the shells from the Arroyo Yalchactilá.

It is possible that somewhere between the two localities will be found colonies of an intermediate character, yet as the two lots stand they seem sufficiently contrasted to warrant subspecific distinction for *lacustris*. This was named originally for a sculptured mollusk. As partly smooth and smooth specimens were found, these were supplied with new designations although sculptured and unsculptured shells can be found in the same colonies. Thus *amphibolus* Fischer and Crosse 1879 has "vertical plaits" that are "rather feeble." In var. *conradti* von Martens 1899, the axial sculpture is undeveloped. Variety *major* Fischer and Crosse 1879 is larger than *conradti* and is of reduced sculpture. In the case of *eliminatus* Fischer and Crosse 1879, the shell is nearly smooth. Other probable synonyms are *terebralis* and *pumilis* of the same authors. All these forms in addition to *lacustris* were taken first in Lake Izabal, Izabal, Guatemala.

Pachychilus largillierti (Philippi) 1843

In the group of *P. glaphyrus* sculpture is absent or reduced to very simple terms. The young are thin, yellowish or reddish shells, becoming black

and more convex. Old specimens may be of a dark, shining brown, often irregularly mottled. The species was taken in numbers at the outlet of Lake Amatitlán, near Guatemala City. This particular lot has the appearance of depauperization. Basal folds, which are a constant in *glaphyrus* and *lacustris*, are absent in 57.5 per cent of ninety-two specimens of *largillierti*. Axial sculpture was not found in any shell. Variety *nodulosus* von Martens 1899 is doubtless a synonym, and probable synonyms are varieties *salvini* and *stolli*, both of von Martens.

Pachychilus corvinus (Morelet) 1849

Egg masses of this species were found from which the infant shells were emerging. These were smooth, pinkish carnelian, translucent, and bluntly rounded at the periphery. The whorls varied from three to three and one-half. With growth the shell generally becomes black, even though the adults may be of a mahogany or yellowish color on the body whorls. The bluntly angled periphery is maintained in specimens three-quarters grown, but in a lot from Arroyo Xotal of the northern area the alteration to rounded whorls was found to be accelerated. The mature shell is smooth, conic, and has a rather large aperture which is sometimes slightly produced.

Fischer and Crosse 1879 have differentiated the light colored specimens from the dark, naming the former variety *lutescens*. In the Arroyo Xotal lot, one shell in three or four hundred is light colored. All the specimens from the Arroyo Petenhá of the Río de la Pasión are black although of a reddish tint when viewed by transmitted light. In material from the Arroyo Yalchactilá, 49.6 per cent of 121 shells are black to dark brown, 29.7 per cent parti-colored, and the rest light brown, entirely or nearly entirely unicolorous. Light brown shells to the amount of 12.3 per cent occur in the 239 shells from a woodland creek near Sebol, these individuals being all adult. On the whole it would seem that loss of pigment is a phenomenon of maturity and that it denotes neither specific nor subspecific differentiation. One shell of a light color which had experienced breakage repaired the break with shell substance black in color. The reverse process was observed in another specimen. The index of obesity in all the lots ranged from 57.0 to 63.6 per cent, and could not be seen to vary with position in stream.

In addition to *lutescens*, *P. cinereus* (Morelet) 1849 and *P. panucula* (Morelet) 1851 appear to be synonyms. The distinction of *Sphaeromelania hinkleyi* Marshall 1920 is only a greatly thickened columella. Pilsbry (1931) has described *P. schumoi* from the Río Negro of the Río Usumacinta which belongs to the *corvinus* complex.

Pachychilus corvinus indifferens Fischer and Crosse 1879

The description of this subspecies applies to certain smooth and slender subfossil shells that were taken on the shores of Lake Petén and Lake Eekibix

of the central area. These mollusks may have been brought to these places by human agencies.

Pachychilus indiorum (Morelet) 1849

Taken in small numbers in a small arroyo below La Ceiba, Alta Vera Paz. Except in color the shells correspond with specimens thus named that were collected by A. A. Hinkley in the Río Cavech, Izabal. The shells are of the *corvinus* group, smooth, tightly coiled, and they have spatulate apertures. The index of obesity of ten shells is 88.4 per cent, contrasting with an extreme of 63.8 per cent in *corvinus*. Synonyms are variety *costata-plicatus* Brot 1872 and *varicosus* Fischer and Crosse 1879. Both would appear to be freaks, the first having low undulations on the body whorl and the other interrupted revolving folds.

Pachychilus planensis Lea 1858

A single specimen was collected at Puerto Barrios. It belongs to the *corvinus* group and has a large and produced aperture. The outer lip is very slightly sinuous. The dimensions of this one shell are virtually the same as those given by von Martens. This author, for unexplained reasons, makes *planensis*, the earlier named species, a variety of *ördstedti* Mörch, which was described in 1860.

Pachychilus pilsbryi von Martens 1901

This species was taken at eleven stations of the Río de la Pasión and in two of its tributary arroyos. While it was collected as far downstream in the Pasión as Sayaxché, Petén, it appears to be characteristically an up-stream inhabitant, more frequently occupying fast water than not. Small differences in the indexes of obesity are noticeable as between colonies. The outstanding character of the shell is the striation. With the exception of the two nuclear whorls, every whorl has revolving folds, either as broken lines in the immediate post-embryonic whorls or as strong ridges on the body whorl.

Specimens were taken which appear to have just emerged from the egg. They vary from four and one-fourth to four and three-fourths whorls, the last two showing a somewhat nodulous sculpture which is produced where the revolving striae cross the primitive and nearly obsolescent axial sculpture. These young have two continuous ridges at the periphery, and are smooth on the base. The aperture is diamond-shaped and produced into a sinus. The outer lip is slightly sinuous in old specimens. The columella is wide, white, continuous, and thickened at the top, and certain individuals have narrow channels at the columellar base suggestive of the sinus of *Hemisinus*.

Eggs of this species were found on the lower surfaces of stones in a current near shore. The egg masses occur as flat layers spread out over flat

objects. The size of the egg mass varies, the number of eggs in some of those observed running from eight to twenty. The eggs themselves are round, shotlike, and transparent. The whole mass is held together by a gelatinous coating. The average size of the individual eggs is 2.8 mm.

Family Unionidae

Psoroniaias semigranosus (von dem Busch) 1845

As understood in the present report several shells from the Usumacinta drainage which have been named as distinct species are considered merely as forms of this one species. There is no question but that *psoricus* Morelet 1849, *corium* Reeve 1864, *morini* Morelet 1851, *crocodilorum* Morelet 1849, *rudis* Simpson 1900, and several others are merely variants of *semigranosus*.

This species was found to be most common in the Río de la Pasión and the Río San Pedro. It was particularly abundant at Mactún in the San Pedro, and even more common in the Pasión on shoals extending from the region of the mouth of Arroyo San Simón (Alta Vera Paz) to Sayaxché (Petén). Within this distributional range, a distance of approximately one hundred and fifty miles, this species goes through a remarkable series of variations. In the same colony there are specimens which are very pustulose, others which are quite smooth; there are some with white nacre, while others grade through pink towards dark purple; and there is also a remarkable variation in obesity (which is simply the product of the width of the shell divided by its length and is expressed in percentages). The following tables have been prepared to indicate variation in obesity in specimens from the several stations in the Río de la Pasión.

STATION	RÍO DE LA PASIÓN
2.	Rodal de Carisal, Alta Vera Paz
3.	Rodal Grande, Alta Vera Paz
4.	Rodal de Embudo, Alta Vera Paz
5.	El Cambio, Petén
6.	Rodal above Tres Islas, Petén
6a.	Tres Islas, Petén
7.	Santa Amelia, Petén
8.	about 13 miles above Sayaxché, Petén
9.	Sayaxché, Petén

Although there is evidence of a definite progressive increase in the size of specimens from the headwaters towards the mouth of the stream, there is not such a progressive increase in obesity, as is evident from a comparison of the means of obesity in Table II.

In Table III a statistical comparison is given for the means of obesity for specimens from the various stations. If every possible combination of this

TABLE II
DATA ON OBESITY OF *PSORONAIAS SEMIGRANOSUS* IN RÍO DE LA PASIÓN, GUATEMALA

Obesity in per- centage	Stations									Total
	2	3	4	5	6	6a	7	8	9	
30									1	1
31										
32										
33										
34									2	2
35							1			1
36										
37							2			2
38										
39						1	1		1	3
40					1		1			2
41					1					1
42									1	1
43					1	2				3
44		1			2		1		2	6
45	1				4	1	4	2	3	15
46					6	1	4	1	2	14
47					2		3		2	7
48	1	1			7	2	2		8	21
49	1			1	10	3	1	2	5	23
50					5	1	1	1	2	10
51	2		2		1	3	3	1	2	14
52	2	2	1		4	4			4	17
53	1		1		3	1	1		4	11
54			1	1	4	2	1	2	7	18
55		1	2		5	1	1	2	3	15
56		3	2		7	1	1	1	4	19
57	1		1		6	2			1	11
58	1		1	1	2	3	1	2		11
59			3	1	1	1		2	1	9
60				1	2			1	2	6
61		1			2	1	1	1	1	7
62		1		1	4				1	7
63		1			4		1	1		7
64			1		2					3
65										
66				1	2	1	1		1	6
67					3	2			1	6
68		1								1
69					3		1			4
70					2				1	3
71				1	1					2
72										
73									1	1
74										
75										
76										
77										
78							1			1
79										
80										
81					1					1
82										
83										
84										
85										
86										
87										
88										
89									1	1
No. spec.	10	12	15	8	98	33	34	19	64	293
Mean	51.6	56.08	55.93	59.87	54.67	53.03	49.94	54.05	52.03	53.48
P.E. mean	.79	1.25	.6	1.51	.54	.77	1.06	.84	.75	
Standard deviation σ	3.69	6.42	3.43	6.35	7.92	6.55	9.18	5.40	8.88	7.93

series were compared, there would be only a very small percentage of such comparisons in which the differences would be significant, since ordinarily five is considered a significant difference. In making this comparison those combinations were selected which contained colonies with the greatest number of specimens and which showed the greatest difference in their means.

Since the comparison of the individual populations revealed that there is no justification for recognizing these various populations as significantly different in obesity to justify the establishment of new species or subspecies, or the recognition of former names used because of these differences, all the lots were combined into one length-frequency group in the last column of Table II.

TABLE III

STATISTICAL COMPARISONS OF THE MEANS OF OBESITY IN *PSORONAIAS SEMIGRANOSUS* FOR THE SEVERAL DIFFERENT LOCALITIES IN RÍO DE LA PASIÓN

Populations compared*	Difference between means	Probable error of difference	Difference divided by probable error of difference
2 and 5	8.27	1.70	4.9
3 and 7	6.14	1.64	3.7
4 and 7	5.99	1.22	4.9
5 and 7	9.93	1.84	5.4
6 and 7	4.73	1.19	4.0
5 and 6	5.20	1.60	3.3
5 and 9	7.84	1.69	4.6
6 and 9	2.64	0.92	2.9

* For the number of specimens represented in the populations being compared see Table II.

The formulae used in the determinations are as follows:

$$(1) \quad \sigma = \frac{1}{N} \sqrt{N \sum fx^2 - (\sum fx)^2}$$

$$(2) \quad P.E.M_x = \frac{.6745 \cdot \sigma_x}{\sqrt{N}}$$

$$(3) \quad P.E.Diff.M. = \sqrt{(P.E.M_1)^2 + (P.E.M_2)^2}$$

Amblema digitata (Morelet) 1849

This species was found to be rare in the area surveyed. Only two valves were found in Río de la Pasión: one on a bar below La Pasión, Petén, another at Tres Islas. Simpson (1914: 822) refers this to the genus *Quadrula*, but it is obvious from the shell characters that it will most likely eventually be grouped with *Amblema*.

Nephronaias calamitarum (Morelet) 1849

Two lots taken from the Río San Pedro have been referred to this species. It was found alive at Mactún Rapids, and again at Arroyo Chocop, which enters the San Pedro about twelve miles above Mactún.

Plagiola nicaraguensis (Lea) 1868

Only one valve of this species was taken at Mactún Rapids on the Río San Pedro. Its occurrence there extends its range considerably north, since hitherto it has only been reported from Nicaragua.

Plagiola sallei (Crosse and Fischer) 1893

Of the Naiades in Río de la Pasión, this was one of the most common. Its distribution in that drainage proved rather limited. The following list seems to indicate its definite restriction to the central part of the Pasión, its numbers becoming decidedly less when either of the extremes are approached. The series is listed in the order of occurrence in a downstream direction.

RIÓ DE LA PASIÓN	SPECIMENS
1. At El Cambio	2
2. Rapids above Tres Islas	50
3. At Tres Islas	25
4. At Santa Amelia	15
5. Above Sayaxché	2

An examination of the soft parts and the glochidia of this species indicates that it is more closely related to *Plagiola* than to any other genus.

Leptodea paludosa (Morelet) 1849

A series of some eleven lots representing collections from the Río de la Pasión and its tributaries, Lakes Eckixil and Petén, and the headwaters of the Río San Pedro, have all been placed under *paludosa*. Careful examination of the specimens from these various areas has led to the conclusion that *paludosa*, *planivalvis*, and *delphinulus*, as listed by Simpson (1914: 192-194), are all one species.

It seems well-established in the lakes and rivers of the Petén area. It was found to exhibit a decided tendency towards retaining a well-developed wing in the quieter waters of lakes and streams. In the more turbulent streams, such as the headwaters of the Río San Pedro, above El Paso de los Caballos, and in the upper Arroyo Subín, the wing tends to break off and an accompanying thickening of the shell in such waters gives the impression that one is dealing with quite a different species from the thinner, usually more alate, specimens common to lakes.

All young specimens, regardless of where they occur, have well-developed wings, and, as is generally known for specimens belonging to alate groups, there is a decided tendency toward a reduction in the size and proportions of the wings with an increase in age of the shell. Other variations occurring in this series concern the thickness of the shell, which may be very thin or moderately thick, and the color of the nacre, which may be white, pink, salmon, or purple. On the whole, this species has all the characters of a *Leptodea*, both in soft parts and in shell characters.

Family Sphaeriidae

Eupera singleyi Pilsbryi 1889²

This species proved to be commonest in the southern area. It was found there in six localities. The shell was given the specific name of *maculata* by Morelet in 1859. The maculations, which suggested the name to Morelet, are adventitious deposits on the inner surfaces of the valves, seldom of the same pattern and frequently altogether absent. In old specimens the animal has covered over the deposits with nacreous material as the Unionidae do with sand, peat, and parasites getting between mantle and shell. The nature of these maculations could not be discovered although to the writers they appear to be parasitic. Similar substances were observed during this study on the shells of *Amnicola petenensis* Morelet. The name *maculata* being preoccupied, Pilsbry substituted *singleyi* for it. Fischer and Crosse proposed *yucatanense* for the same purpose. This was five years later than Pilsbry's action.

Pisidium singleyi Sterki 1898

Found in two localities of the southern area, and also in Lake Amatitlán, southwest Guatemala.

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² The use of *Byssanodonta* D'Orbigny 1846 as a substitute for *Eupera* Bourguignat 1854 does not seem to us to be justified by the description of *Byssanodonta* and only vaguely by the three figures. Description and illustrations are to be found in *Voyage dans L'Amérique Méridionale*, 5, 1847: 622, Figs. 21-23.

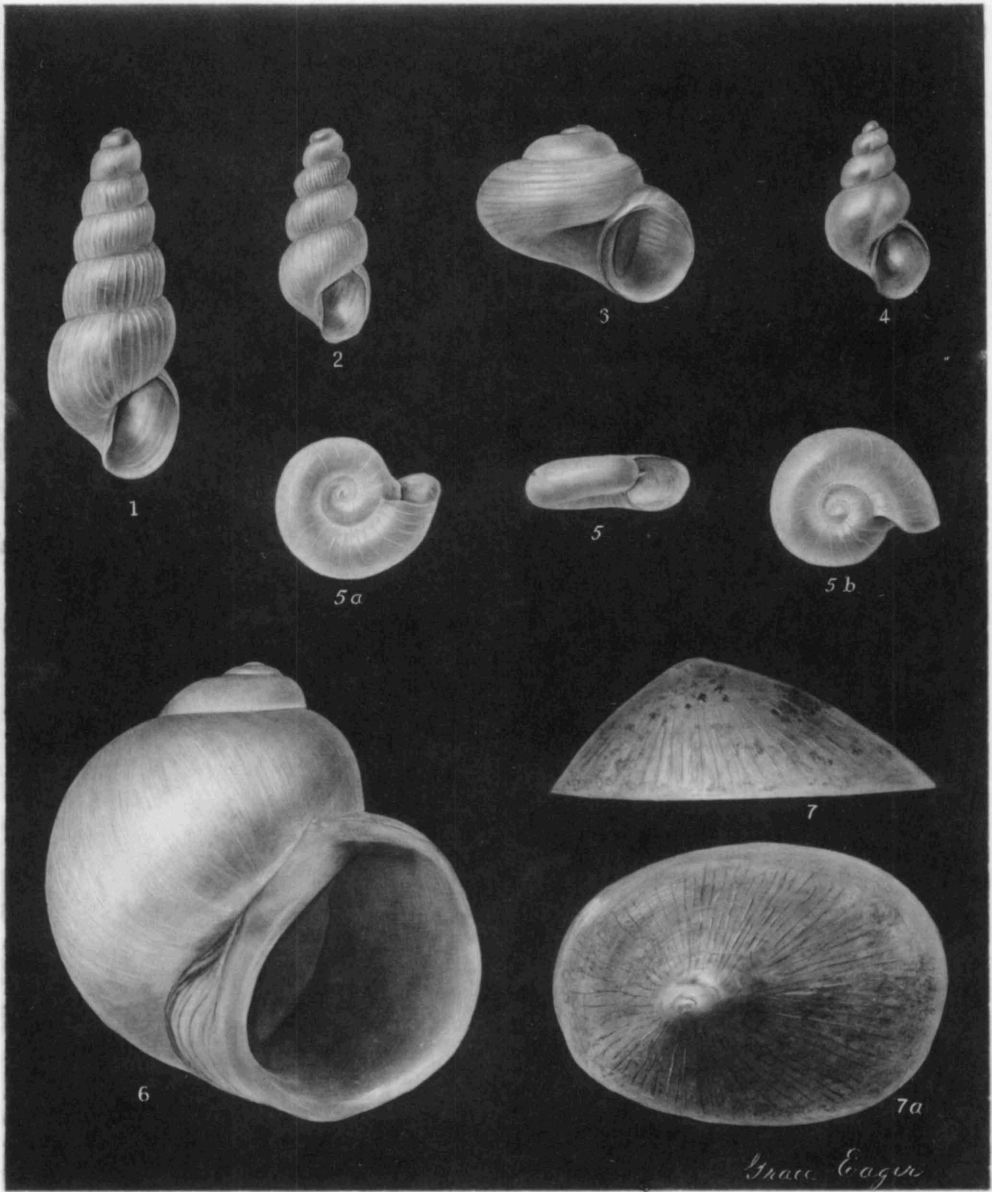
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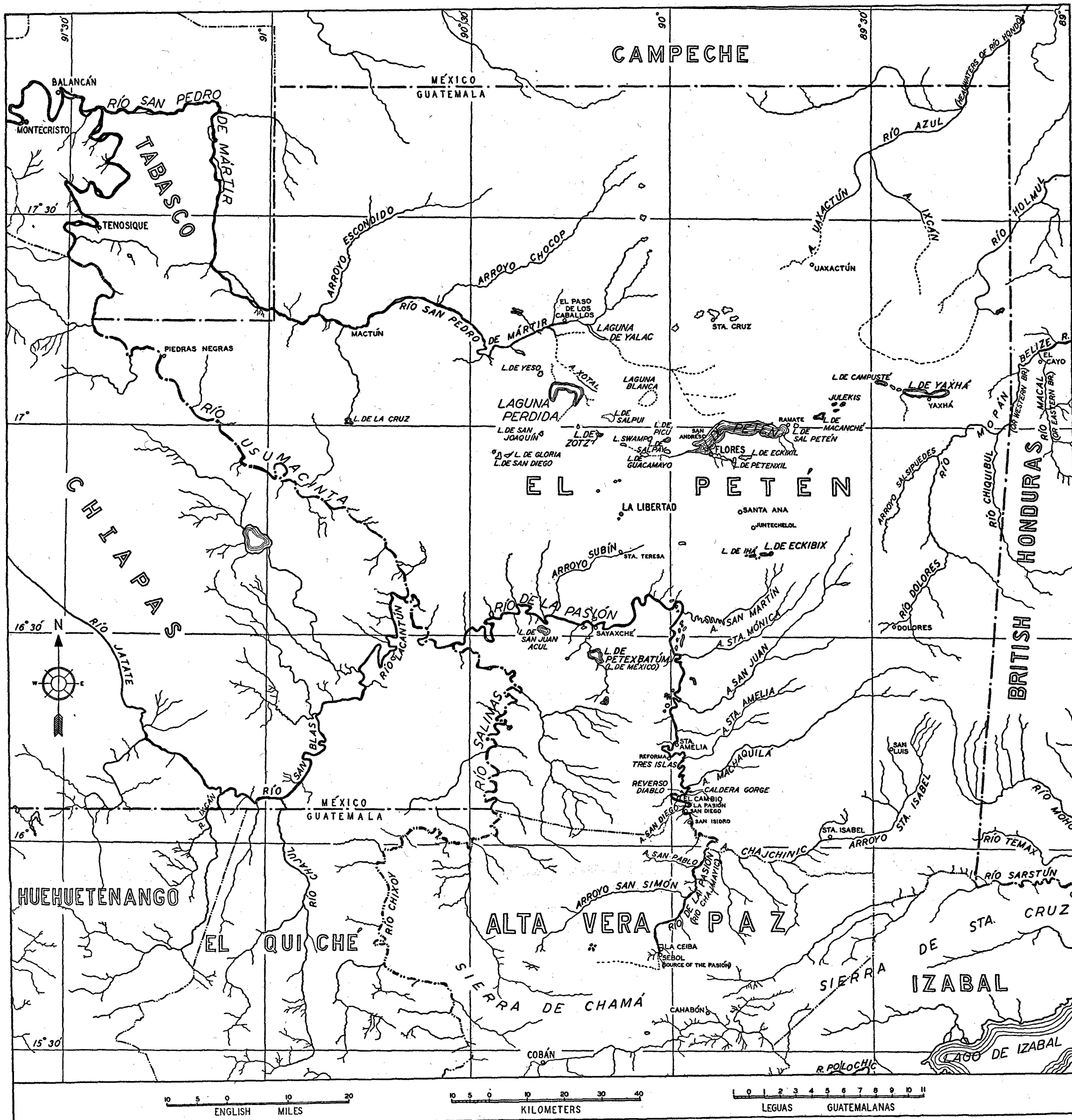
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PLATE I

- FIG. 1. *Spiraxis alvaradoi* Goodrich and van der Schalie. Holotype. Limestone knoll five miles north of El Paso de los Caballos, Petén, Guatemala.
- FIG. 2. *Spiraxis funibus* Goodrich and van der Schalie. Holotype. Limestone knoll five miles north of El Paso de los Caballos, Petén, Guatemala.
- FIG. 3. *Cochliopa francesae* Goodrich and van der Schalie. Holotype. Río de la Pasión, northwest of Porvenir, Alta Vera Paz, Guatemala.
- FIG. 4. *Ammicola pasionensis* Goodrich and van der Schalie. Holotype. Río Subin, two miles above Santa Teresa, Petén, Guatemala.
- FIGS. 5-5b. *Xenodiscula taintori* Goodrich and van der Schalie. Holotype. Woodland east of El Paso de los Caballos, Petén, Guatemala.
- FIG. 6. *Somatogyrus clenchi* Goodrich and van der Schalie. Holotype. Río de la Pasión, Sayaxché, Petén, Guatemala.
- FIGS. 7-7a. *Ferrissia aguadae* Goodrich and van der Schalie. Holotype. Aguada de Copó, one mile south of La Libertad, Petén, Guatemala.





MAP 1. EL PETÉN, GUATEMALA, AND BOUNDING REGIONS OF BRITISH HONDURAS AND MEXICO (CHIAPAS, TABASCO, AND CAMPECHE)

Compiled by Carl L. Hubbs and Henry van der Schalie, 1937

Scale 1: 1,000,000 (1.58 miles per inch; 10 kilometers per centimeter)

AUTHORITIES: Based chiefly on "Mapa del Estado de Guatemala Republica de Centroamerica Compilado por Disposición del Supremo Gobierno por Claudio Urrutia (L. Friederichsen y Cia., Hamburgo), 1923," scale 1: 400,000,—with corrections from: "Mapa de El Petén Guatemala Centro-América por Hakon Wadell 1923-1924," scale 1: 400,000 (blueprint furnished by Carnegie Institution); "Map of the Department of Petén, Guatemala, and Adjacent Regions, Showing Routes of the Central American Expeditions of the Carnegie Institution of Washington Compiled 1933-1934," scale 1: 500,000; "Map of Laguna de Petén, Guatemala, C. A. Surveyed by J. O. Kilmartin, U. S. Biological Survey, for the Carnegie Institution of Washington, 1923," scale 1: 24,000; "Central Petén, Guatemala," scale about 1: 1,136,000 [map prepared by L. C. Stuart from various sources and used in several of the University of Michigan Museum of Zoology Miscellaneous Publications, 1935]; "Map of British Honduras Drawn and Compiled from Various Sources by E. Lassen, 1911," scale 1: 380,160; "Atlas Geográfico de la República Mexicana Construido y Editado en la Dirección de Estudios Geográficos y Climatológicos, Secretaría de Agricultura y Fomento, 1929-1930"; and observations from air and land by Carl L. Hubbs and Henry van der Schalie on the Fifth Carnegie Institution-University of Michigan Expedition, of 1935, chiefly between Laguna de Petén and the source of the Río de la Pasión.

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