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NOTES ON THE HABITATS OF SOME TROPICAL
SPECIES OF HETAERINA (ODONATA)

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GENERAL CONSIDERATIONS

Dragonflies are comparatively rare in nature, although many sometimes congregate in a very restricted habitat, as a narrow belt of vegetation about a lake or the ripple on some stream, and, from observations at such stations, one may get an exaggerated idea of the number of individuals of certain species. The activity of some species often gives the same impression. A small pond near Nirgua, Venezuela, one day was "alive with Trameas." Late that afternoon the Trameas abandoned the pond to rest a few feet from the ground on the twig tips of nearby dead bushes. Lowering one's head to the ground brought these resting dragonflies against the sky line and it was an easy matter to see and net all these resting individuals which had successfully eluded the net during the day. A few trips around the pond resulted in the

capture of all of them, and the total was less than thirty individuals. The next day at the pond *Trameas* were conspicuous by their absence.

Once in Guatemala I had collected about Gualan for several days with poor success. It was the very end of the dry season, and the woods and fields were tinder dry. Then one night it rained, a veritable downpour, for hours. And about the little ponds which came into being between sunset and sunrise along the railroad embankment *Trameas* and other libellulines flew "by hundreds" in the early morning sun. And yet, during the preceding days of drought I had not seen a *Tramea*. They were really few in numbers and were scattered far and wide through the brush and over the fields. Dragonflies would be almost unknown except to a few specialists, if it were not for their congregating at times of greater or lesser duration in habitats of very restricted area.

Yet these habitats may be occupied for only a brief period in the lives of the dragonflies. Because of their freedom of flight, their relative independence of any one certain food, and their limited numbers, dragonflies present in many cases a difficult problem for one who would discuss their habitats intelligently. To say, for example, of some species of *Somatochlora* that it "frequents woodland streams," may tell about as much about it as the student would learn of the activities of Charles Darwin, say, if his biographer told where Mr. Darwin spent his youth and gave the street address and house number of his later years. For the chances are that our *Somatochlora* from the date of its emergence till its final activity (mating) may never visit the woodland stream. We find it at a certain period in its life at a habitat of very small area, where it meets others of its kind.

Dragonflies as adults, when they are usually most readily observed, may have a very short life, and a few days difference in visiting some suitable habitat may result in the failure to find a single individual of a certain species which may have been there in numbers a few days before or after the visit.

Some dragonflies also vary from year to year, due to early or late seasons, in the time of their appearance. If their season is very short, the student, if not continuously in the field, looking for the species only on certain dates, may miss it entirely.

Some dragonflies, if not all, seem to occur in relatively large numbers only at intervals of undetermined duration. The species maintains itself continuously in a certain habitat, but has "lean and fat years." This phenomenon may be obscured or confused by the ebb and flow of odonate life described in a later paragraph.

Many dragonflies are very susceptible to some other conditions which are probably meteorological. On a certain day a pond, for example, may be alive with the active individuals of many species. The succeeding day may be, to the observer, similar to the day before, but at the same pond fewer species and a smaller number of individuals may be on the wing.

The student of habitats encounters another difficulty. Dragonflies "come and go"—there are great ebbs and flows over long periods. I do not refer to the occasional individual strays or waifs, of which the collector finds a few during many years of collecting, but rather to large and, apparently at the time, successful invasions of a new habitat. Two good examples come to mind. Near Bluffton, Indiana, is a woodland swamp of possibly three or four acres. I have had this pond under observation for over twenty years. One year *Libellula quadrimaculata* appeared there in great numbers.

They were easily the dominant dragonfly and any student of habitats would have pronounced them one of the essential factors in the balance of this woodland pond. But *Libellula quadrimaculata* has appeared at this pond only once. Twice during my observation of this pond *Ecnallagma* have appeared. One of these years was 1920, when *Ecnallagma* probably exceeded in numbers all other dragonflies on the wing at the pond during the same season. Flying a few inches above the water, resting on grass stems, willow tips, and spatter-dock leaves, on the broad surfaces of which the females were ovipositing, they dominated the entire pond. But they were not there in 1919 or in 1921. The changes which take place from year to year in any odonate society such, for example, as an abandoned gravel pit, may be obscured or subject to misinterpretation due to these ebbs and flows of odonate life.

Still another factor is involved which makes general conclusions as to the character of the habitat of any species of dragonfly dangerous: the great adaptability shown by certain species to thrive in very different habitats. Such differences are usually, if not always, associated with differences in geographical location. For example, *Libellula incesta* frequents glacial lakes in northern Indiana, especially about growths of *Scirpus*, spatter-dock and water-lilies. It never occurs about small, muddy, sun-exposed buttonwood ponds; but in Tennessee it does occur about just such unattractive ponds, where no self-respecting Indiana *incesta* would fly. A species may be a lake-dweller in part of its range, a pond-dweller elsewhere, and a stream-dweller at a third location.

Another difficulty in describing habitats arises from seasonal differences or evolutionary changes in the habitats which may escape the casual observer. For example, a succession of muddy pools at one season may be a deep, swift-

flowing stream at another season. And miles of lagoons may a few years before have been part of a swift-flowing river. In the first case a dragonfly species on the wing throughout the year may occupy the habitat because of conditions at a certain season, though other seasons bring conditions incongruous with the general preferences of the species; and in the second case, a species may survive at least for some time in the lagoon, though its preferences are for the stream from which the lagoon was formed.

Some dragonflies, such as the *Tameas*, mentioned above, and there are many others, range far and wide. Others, such as the *Enallagma*, apparently live their lives practically in one habitat. But that this is only apparent is obvious when one considers the sudden appearance of large numbers of *Enallagma* at rare intervals at a small, isolated swamp, surrounded by forest, with no known habitats of the same species within fifty miles or more. The known distribution of many species of apparently very circumscribed habitats also bears this out.

Species of *Hetaerinas* are dragonflies of a very circumscribed habitat, and no others known to me during imaginal life apparently remain closer to the location where their eggs are laid and where their nymphal lives are passed. As to how the distribution of the species of the genus has come about we know as little as we do of the origin of the species themselves. But taking this into account, I know of no other genus in the order where one may more safely record observations on habitats with some certainty that such observations are definitely descriptive of the species observed, and not the record of some mere accident in the life of the species. As an example of the latter kind, I might mention the discovery of a number of larvae of *Pantala hymenaea* successfully living

and maturing in a cement water trough in an Indiana farmyard.

Moreover, Hetaerinas in the tropics are on the wing apparently throughout the year, and they are not as susceptible as most dragonflies to meteorological conditions. They are, therefore, less likely to be overlooked by the collector who may spend only a day or two at a particular habitat. Their habits and bright colors render them conspicuous, so they are detected by even the superficial observer.

The facts just given permit more positive statements as to habitats and distribution of species of Hetaerina than is possible for the larger number of dragonflies.

The largest number of species of Hetaerina observed on a continuous short stretch of any stream is four, and on such streams the number of individuals is generally large. Such an optimum habitat may be briefly described. As stated, it is a stream, for all Hetaerinas live about running water.* The stream is small, two to six feet wide, with small waterfalls, many ripples and some quiet pools. It is usually in forest or brush, with bushes overhanging the water. In the stream may be a few arums, growths of *Cyclanthus*, or other similar aquatics. The stream will have any part of its course alternately in sun and shadow, and the ripples generally receive more sun than the pools. About such a sunny ripple and the adjacent courses of the stream, resting on the leaves or twig tips of overhanging bushes or on the aquatic vegetation, and flitting from one perch to another, Hetaerina, so far as we can observe, spends its imaginal life.

With species of some other genera in the tropics, many of the Hetaerinas live about smaller streams and are more shade-

* Rarely individuals, apparently strays, are taken about ponds or similar pools, or drought may reduce the stream where they occur to a succession of pools.

dwelling than any species we have in the north temperate region. But the larger number of stream-frequenting dragonflies of both the tropical and the temperate regions are equally attracted by ripples. It may be the sun shines more continuously there than on the pools, that food is more plentiful, that luxuriant aquatic growths furnish convenient perches and the leaves and stems suitable receptacles for dragonfly eggs, and that oviposition directly in the water by other species is safer. At any rate, about the ripples of the larger northern stream Hetaerinas, Enallagmas and gomphines congregate at their season, while the ripples of some tiny brook in the tropical jungle flashes with the brilliant blues of *Argias* and *Coras* and the red of Hetaerinas.

Tropical streams of about the same size as those in the north where Hetaerinas may occur, streams thirty feet wide or larger, have few, if any, Hetaerina inhabitants. In fact, odonate life generally is rare on these larger tropical streams. A few species find them congenial, and some others find suitable homes adjacent to the river in little habitats such as pools at the face of a cliff, a log jam, or a bit of old river bed, but not parts of the river habitat itself. These larger tropical streams rarely attract Hetaerinas.

The small streams where the bulk of Hetaerina life in the tropics is found are probably in most cases more recent than the species of Hetaerina which frequent them. If this is true, such streams received their Hetaerina faunas by migration. As to how this has come about, as stated before, we know as little as we do about the origin of the species themselves. Certainly, the species are not or have not always been as bound to their restricted habitats as our observations would indicate.

The distribution of Hetaerinas on a particular stream may be such as to still farther complicate any ideas we may have as to the manner of distribution. For example, suppose there are several small streams flowing in the same direction from the same range of hills and crossing a narrow coastal plain to enter the sea. It is obvious that the streams will approach their neighbors on either side very closely at their ramified heads. Moreover, these headwaters will approach very closely the headwaters of streams flowing in the opposite direction from the range of hills. Given a species of Hetaerina on one of these streams, it is obvious that it might reach adjacent streams across the coastal plain or by the narrowly divided headwaters, which would also permit the extension of the species to the opposite side of the range of hills. These two courses offer apparently the easiest paths for the dispersal of the species.

But the problem is not so simple. Let us look at the Rio San Esteban in Venezuela. Where it leaves the rocks to flow, still swiftly, in its sandy bed across the coastal plain, *Hetaerina caja* is abundant. Upstream among the rocks and in the lower courses of the tributary quebradas *Hetaerina macropus* is found. And at the heads of these quebradas, where the rock masses are the roughest and most precipitous, lives the largest and handsomest of the San Esteban Hetaerinas, *capitalis*. And on the opposite side of the mountains at Bejuma, for example, in the Orinoco drainage, we find the same distribution of the same species. Furthermore, at Maraquita, far away in the interior of Colombia, seven or eight hundred miles up the Magdalena River, we find the same three species with the same distribution.

We may assume that these three locations, with streams of similar character, have been in the line of similar flows of

odonate life. Over other streams these flows have passed, leaving no trace. For example, three or four kilometers back from the Rio Magdalena at Puerto Berrio is a muddy forest stream which we found very rich in odonate life, but we found not a single Hetaerina there, though at Cristalina, distant about 25 kilometers, four species occur, one of them in large numbers. A similar muddy stream without Hetaerinas was found near Cumuto in Trinidad. In British Guiana are species of Hetaerina which would very probably find the Puerto Berrio and Trinidad streams congenial, but these species have never flowed over the far distant similar habitats in Colombia and Trinidad. The Hetaerina fauna of a tropical stream is determined by its congeniality or lack of it for the various species which, because of its geographical position, are enabled to reach it.

The character of a stream, its rate of flow, the temperature and composition of its water, the geology of its bed, its fauna and flora, are all subjects which may be studied and determined. But the means or methods by which its plant and animal inhabitants have reached it are not so readily analyzed. As stated before, as to the dispersal of dragonfly species we know as little as of their origin, and the problem is difficult, if not impossible, of solution. Referring again to the Rio San Esteban in Venezuela, we find three species of Hetaerinas definitely distributed on the stream. These are *caja*, *macropus*, and *capitalis*. To the west across the mountains, at the swift streams about Tachira, we find two of these, *macropus* and *capitalis*, and a few kilometers lower down at La Fria, where the streams run out into sand, we find *macropus* and *caja*. But at both Tachira and La Fria occur also the widely distributed *miniata*, which is not known east of the Catatumbo River basin, in which both Tachira and La

Fria are located. At Cristalina, in the Magdalena basin, all four species, *caja*, *macropus*, *capitalis* and *miniata*, occur. Why should *miniata* have stopped at the Catatumbo when the apparently more specialized *caja* ranges far to the east and west?

Another genus of dragonflies which is as closely confined to streams as Hetaerina is Heteragrion. In the San Esteban and Yaracuy valleys and over the mountains from them in the Orinoco drainage occurs *Heteragrion chrysops* alone. In the Magdalena basin, far to the west, occurs *Heteragrion mitratum* and three other species, but not *chrysops*. But in the Catatumbo basin *chrysops* and *mitratum* both occur. If *chrysops* could come as far west as the Catatumbo and *mitratum* could come as far east, and both find a congenial habitat there, why has not *mitratum* extended its range to the east, over the path *chrysops* has come; and why has not *chrysops* ranged westward to the Magdalena by the same route *mitratum* has travelled?

SPECIES AND LOCALITIES

In a former paper (Misc. Pub., Mus. Zool., Univ. of Mich., No. 9) I have listed the several collecting trips to the American tropics in which I have had a part or from which I have obtained the dragonflies for study. This paper deals with the Hetaerinas, numbering over 3,500 specimens, which have been taken on these trips. The Guatemalan Hetaerinas, collected in 1905, have been fully dealt with by Dr. Calvert in the B. C. A., and they are not again referred to in this paper. The records from a single stream in Honduras, collected the same year and already incorporated in the B. C. A., are, however, again listed for purposes of comparison. The large lot of material on which this paper is based has been

identified, labelled and arranged for distribution to students by Mr. J. H. Williamson. He also prepared in tabular form a complete list of localities, with the species taken at each locality. This tabulation was invaluable in the preparation of this paper. Dr. Calvert and Dr. Ris have checked Mr. Williamson's determination of species from a set of specimens sent to each, and the determination of three species, *laesa*, *moribunda*, and *mortua*, rests upon Dr. Ris's authority.

In this paper, when reference is made to the Hetaerinas of Venezuela or of Colombia, for example, only the species taken on the trips mentioned in the first paragraph are implied. It is not the purpose of this paper to discuss other hitherto published records either of species or localities. Neither does this paper deal with specific characters or relationships. Too many species of Hetaerina are wanting in my collection to render such an attempt practical. Of the species discussed in this paper I have retained large series of specimens for my collection, and these are available at any time for any student who will undertake a systematic revision of the genus.

The localities represented by the specimens before me may be conveniently summarized as follows: In Guatemala, a section across the country on the line of the transcontinental railroad; two stations on the railroad in Panama; the Santa Marta region and the valley of the Magdalena to just above Honda in Colombia; the north coast of Venezuela west of La Guaiara, a few nearby tributaries of the Orinoco, and stations in the Rio Catatumbo drainage south of Lake Maracaibo; streams in northern Trinidad; two stations in the department of Junin, Peru; and stations in the Demerara and Essequibo river basins, all within one hundred and fifty miles of the coast, in British Guiana. All localities are alphabetically arranged and briefly described in the last part of this paper.

Central America has a rich Hetaerina fauna with sixteen known species. All five of the Colombian species listed in this paper occur also in Central America; the four Venezuelan species occur in Colombia and Central America; and the two species known from Trinidad also are common to Central America, Colombia and Venezuela. But of the three Peruvian species before me, only one occurs also in the material from the regions mentioned in the preceding sentence; and the four species from British Guiana are not represented at all in material from the other regions.

Awaiting a careful study of the relationships of the Hetaerina species, such as Dr. Kennedy has recently made of the *Libellula* species (*Entomological News*, XXXIII, March and April, 1922), the species here discussed are arranged alphabetically in the text.

These fifteen species of Hetaerina are alphabetically arranged and consecutively numbered in the list below. Under the discussion of each species, following each locality, are numbers in parentheses indicating the other species of Hetaerina taken in that locality. For example, under *H. americana*, *Guatemala*, Agua Caliente (5, 9), indicates that at Agua Caliente, in addition to *americana*, *cruentata* and *macropus* were taken. The species are:

- | | |
|---------------------------|-------------------------|
| 1. <i>H. americana</i> | 9. <i>H. macropus</i> |
| 2. <i>H. caja</i> | 10. <i>H. miniata</i> |
| 3. <i>H. capitalis</i> | 11. <i>H. moribunda</i> |
| 4. <i>H. charca</i> | 12. <i>H. mortua</i> |
| 5. <i>H. cruentata</i> | 13. <i>H. pilula</i> |
| 6. <i>H. dominula</i> | 14. <i>H. sanguinea</i> |
| 7. <i>H. fuscoguttata</i> | 15. <i>H. titia</i> |
| 8. <i>H. laesa</i> | |

1. *Hetaerina americana* Fabricius.

Guatemala, Agua Caliente (5, 9), Amatitlan (5), Gualan (9, 15).

In Guatemala, as well as in North America, this species frequents larger streams, usually fifteen feet or more in width. In the Motagua River basin it does not seem to descend lower than Gualan, which point marks the highest extension up the valley of *H. tithia*.

2. *Hetaerina caja* Drury.

Panama, Rio Mazamba (10), Rio Sardanilla (7, 9, 10); Colombia, Aracataca, Bolivar (3, 9), Cristalina (3, 9, 10), Don Jaca, El Banco, Fundacion, Maraquita (3, 9, 10), Rio Frio (9), Santa Marta (9), Sevilla; Venezuela, Bejuma (3, 9), Boqueron (9), Caserio Silva (9), El Guayabo (10), La Fria (9, 10), Nirgua (3, 9), Palma Sola (9), Salom (9), San Esteban (3, 9), San Felipe (9), Tucacas; Trinidad, Arima, Chaguanas, Cumuto, Cunapo River (9), Diego Martin River (9), Maracas River (9), San Juan River (9), St. Joseph River (9).

This species and *H. macropus*, in about equal numbers, are each represented in our collections by many more specimens than is any other species. It seems to prefer more exposed streams than its associates, occurring on the sunniest stretches of streams where their flow is slower and the bed less rocky. In a hilly country such habitats are found at the edge of the hills where the streams pass into level valleys.

Two fairly well-defined series are represented in the material; a larger, with darker thoracic markings and more extensive and darker basal wing markings in the male; and a smaller, with paler thorax and with reduced and paler basal wing markings in the male. The former occurs in Panama and Colombia and in the Catatumbo region (La Fria and El Guayabo) in Venezuela; the latter occurs in Venezuela east of the Catatumbo region and in Trinidad. Our opinion that only a single species is represented in the lot has been confirmed by Dr. Calvert and Dr. Ris. The red spot on the apex

of each hind wing varies in specimens from the same locality from one-half the usual size to the larger normal-sized spot. A male from Santa Marta has one front wing with a small apical red spot, and another male from the same locality has both front wings so spotted.

3. *Hetaerina capitalis* Selys.

Guatemala, El Fiscal (5, 9); Honduras, San Pedro Sula (5, 9, 10); Colombia, Bolivar (2, 9), Cincinnati (5, 9), Cristalina (2, 9, 10), Maraquita (2, 9, 10); Venezuela, Aroa (9), Bejuma (2, 9), Nirgua (2, 9), San Esteban (2, 9), Tachira (9, 10).

The Central American specimens have the thoracic dark markings more metallic green than the others where the markings in the males are usually a reddish or purplish black, and the females are sometimes similarly colored. There is considerable variation in size, but this is independent of locality. Two males from Cristalina measure, respectively, abdomen, 34 and 41, and hind wing, 26 and 30.

At San Esteban we noted: "Flies sometimes in dark places and alights near the water on rocks; under these conditions very hard to see or to follow flight." *Capitalis* occurs in the darkest habitats in which we have found Hetaerinas in the tropics. Such habitats frequently occur at the extreme headwaters of rocky quebradas. It is not impossible that our failure to find *capitalis* at certain localities where its invariable associate, *macropus*, flies, as, for example, in Trinidad, may have resulted from inadequate exploration of the streams to their headwaters.

4. *Hetaerina charca* Calvert.

Peru, Colonia del Perené (9, 14).

From the limited data available *charca*, like *capitalis*, seems to prefer the headwaters of the quebradas on which it occurs.

5. *Hetaerina cruentata* Rambur.

Guatemala, Agua Caliente (1, 9), Amatitlan (1), El Fiscal (3, 9); Honduras, San Pedro Sula (3, 9, 10); Colombia, Cincinnati (3, 9).

This species occurs in the Cauca Valley, and I am at a loss to explain its absence at Cristalina, where *caja*, *capitalis*, *macropus*, and *miniata* occur, when the stream at San Pedro Sula, almost identical in character with some of the Cristalina streams, has the same identical Hetaerina fauna, except that *cruentata* replaces *caja*. This is especially puzzling since *cruentata* seems a more adaptable species than *caja*.

The Santa Marta (Cincinnati) specimens are distinctly larger and have darker thoraces than any of the other specimens. The altitude at which we found this species at Cincinnati and our failure to find it nearby at lower elevations, though it is found at a much lower elevation to the north in Honduras, indicates that in the Santa Marta Mountains an isolated colony of the species is working out its destiny along new lines. The Santa Marta males vary from abdomen, 39-43, and hind wing, 30-34, but we found only one this small, as the average size is abdomen about 42 and hind wing about 33, about the size, by the way, of the Colombian specimens Hagen called *lineata*. Bogota and Cauca specimens do not differ from Central American specimens, and among these the males measure, abdomen about 35 and hind wing about 26.

6. *Hetaerina dominula* Hagen.

British Guiana, Rockstone (8, 11), Tumatumari (8, 11, 12), Wismar (11, 12).

In some highly colored males, in which the basal red area of the wings is strongly developed, the front wings, as well as the hind wings, have a well-defined, distinct apical red spot, but this is smaller than the corresponding spot in the hind wings. Males evidently slightly teneral have the apex of the front wings clear and the apex of the hind wings without a trace of red, but slightly brown-clouded. In some adult males the red tip of the hind wings is narrowly black or dark-edged apically.

7. *Hetaerina fuscoguttata* Selys.

Canal Zone, Panama, Rio Sardanilla (7, 9, 10).

8. *Hetaerina laesa* Hagen.

British Guiana, Rockstone (6, 11), Tumatumari (6, 11, 12).

Dr. Ris writes that he has this species from Pará, Prata (100 kilometers east of Pará), Obidos, and a large series from the Tapajos. "The Tapajos series is different in that only a single male has the wing bases red as it is in all the other specimens; in these Tapajos males the wing bases are yellowish, though the specimens are apparently mature. I had long ago identified the specimen from Pará as *laesa*, and I believe this determination is correct."—Ris. In the Mon. Calop. the front wings are described as minutely tipped red. This red is not evident in the British Guiana specimens.

9. *Hetaerina macropus* Selys.

Guatemala, Agua Caliente (1, 5), El Fiscal (3, 5), Gualan (1, 15), Los Amates (10, 15), Santo Tomás (10, 13, 15); Honduras, San Pedro Sula (3, 5, 10); Canal Zone, Panama, Rio Sardanilla (2, 7, 10); Colombia, Bolivar (2, 3), Cincinnati (3, 5), Cisneros, Cristalina (2, 3, 10), Maraquita (2, 3, 10), Rio Frio (2), Santa Marta (2); Venezuela Aroa (3), Bejuma (2, 3), Boqueron (2), Caserio Silva (2), La Fria (2, 10), Macuto, Nirgua (2, 3), Palma Sola (2), Salom (2), San Esteban (2, 3), San Felipe (2), Tachira (3, 10); Trinidad, Cunapo River (2), Diego Martin River (2), Maracas River (2), San Juan River (2), St. Ann River, St. Joseph River (2); Peru, Colonia del Perené (4, 14).

This is a widely distributed and apparently very adaptable species. It is also remarkable in the great variation in the development of the stigma. As in the lot of *H. caja*, but not quite so distinctly, there are two series in the present material of *H. macropus*, one series having the basal wing markings of the males darker and more extensive, and the other with this color more restricted and paler. The first series occurs in Central America, Colombia, and the Cata-

tumbo region of Venezuela. The second series occurs east of the Catatumbo region in Venezuela and in Trinidad. In their distribution the two series thus correspond to the two series of *H. caja*. This paler fauna east of the eastern Cordillera is probably correlated with a drier atmosphere than that of the large river valleys to the west.

The three males from Peru are still more distinct and indicate a departure from the more typical form along the same lines as those of the Santa Marta Mountains form of *H. cruentata*. These specimens are the largest and richest colored of the entire lot. The character of size is, however, not as striking as in the case of the specimens of *H. cruentata* referred to above. Specimens of *H. macropus* of different sizes occur in each locality where the species is found, and this variation, except in the case of the Peru specimens, seems independent of locality. Specimens from Panama and Trinidad, for example, measure the same (male, abdomen 36, hind wing 25 or 26), and specimens from the Santa Marta Mountains (Cincinnati), Maraquita and Caserio Silva vary from that size up to males with abdomens 40 or 41 and hind wings 27 or 28. The Peru males, however, have the abdomen 43 and the hind wing 30, a size not attained by any other specimens before me.

It has hitherto been difficult or impossible to separate the females of this species from certain females of *H. titia*. In the female of *macropus*, at about midlength of the middle lobe of the prothorax, on either side just above the suture between the pronotum and the propleuron (that is, about on the level of the lateral extremities of the front and hind lobes of the prothorax), there is a small but distinct outwardly directed antenna-like projection. At the same place on the prothorax of the female of *H. titia* there is a scarcely discern-

ible elevation or small knob. When the species of Hetaerina are carefully studied, other valuable specific characters will be found in the prothorax.

In *macropus* the brown tips of the wings are more evident in teneral specimens than are the red tips in tenerals of other species where the hind wings or all four wings are red-tipped in the adults.

10. *Hetaerina miniata* Selys.

Guatemala, Los Amates (9, 15), Puerto Barrios (15), Santo Tomás (9, 13, 15); *Honduras*, San Pedro Sula (3, 5, 9); *Canal Zone*, Panama, Rio Mazamba (2), Rio Sardanilla (2, 7, 9); *Colombia*, Cristalina (2, 3, 9), Maraquita (2, 3, 9); *Venezuela*, El Guayabo (2), La Fria (2, 9), Tachira (3, 9).

The South American specimens average slightly larger than those from Guatemala and Honduras, and the basal red on the wings of the males is more extensive. The Canal Zone material is insufficient in quality and quantity to determine its status.

This species has been recorded for relatively few localities, and yet at such streams as at San Pedro Sula, Cristalina, and La Fria it seems the most successful species. For example, four species of Hetaerina occur at San Pedro Sula, and of the total number collected there over 65 per cent were *miniata*; at Cristalina, also with four species, of the total number collected over 75 per cent were *miniata*; and at La Fria, with three species, of the total number collected over 88 per cent were *miniata*.

11. *Hetaerina moribunda* Hagen.

British Guiana, Rockstone (6, 8), Tumatumari (6, 8, 12), Wismar (6, 12).

Dr. Ris writes: "I have specimens of this species from

Obidos and Tapajos, Brazil, and I believe it is *H. moribunda*."

12. *Hetaerina mortua* Hagen.

British Guiana, Tumatumari (6, 8, 11), Wismar (6, 11).

Dr. Ris writes: "After re-examining your specimens, representing a species not heretofore known to me, I am almost certain it is *H. mortua*. The description of the thoracic pattern does not fully agree, but the rest of the description and the figure of the appendages in the Mon. Calop. seem to indicate your species. It is strangely similar to *H. dominula*, but there are rather striking differences in both the superior and inferior appendages." In the field it will be difficult to distinguish these two species (*dominula* and *mortua*), even with the aid of a small hand lens. In the males, *dominula* has the red apical spot of the hind wings duller, more diffuse and with some brown edging, and the post-occipital tubercles are low and rounded, scarcely discernible to the unaided eye; in *mortua* the apical red spot is bright, not diffuse, and with imperceptible brown, and the post-occipital tubercles are angular and plainly discernible.

13. *Hetaerina pilula* Calvert.

Guatemala, Santo Tomás (9, 10, 15).

Heretofore only two specimens of this species, one from Mexico and one from Guatemala (B. C. A.), have been known.

14. *Hetaerina sanguinea* Selys.

Peru, Colonia del Perené (4, 9), San Ramon.

This species was found on the lower, slower and sunnier parts of quebradas, and, in its relation to *charca*, resembles the frequent relation of *caja* to *macropus*. *Macropus* was also taken at Colonia del Perené, but only at one place, and its distribution on streams, relative to *charca* and *sanguinea*, was not determined.

University of Michigan

15. *Hetaerina titia* Drury.

Guatemala, Gualan (1, 9), Los Amates (9, 10), Morales, Puerto Barrios (10), Santo Tomás (9, 10, 13).

In the Motagua Valley this species occurs from sea level at Puerto Barrios to Gualan, where it meets *americana*, which descends no farther down the valley. It was well established at Gualan, at Los Amates 84 per cent of all the Hetaerinas taken were this species, and at Puerto Barrios over 97 per cent were this species. If I have been correct in regarding *tricolor* as a synonym of *titia*, this species, when its occurrence at sea level in Guatemala is taken into account, has a surprisingly wide distribution to the north, where it reaches Illinois, Indiana, Ohio and Pennsylvania in the United States. Occurring at sea level in Guatemala, one might expect an extensive range south of Guatemala, but the species occurs no farther south than Nicaragua, but little farther than *americana*. In view of the great similarity in the geographical distribution of the two species (*americana* and *titia*), their habitat distribution in the Motagua Valley is difficult to understand. And in Indiana I am at as great a loss to explain their abundance on some streams and their absence from others.

The amount of variation in the wing coloring of males from the same locality is surprising. The lightest colored male in the present material is from Gualan, and is intermediate between figures 1 and 2, plate 3, B. C. A. But from the same locality there is a teneral male with all four wings brown, and therefore darker than the extreme case figured by Calvert (figure 15, *loc. cit.*). I cannot tell certainly from the present material, but it is probable that wings of teneral males are suffused with brown over a larger area than is occupied by the darker brown or black of their maturity.

ALPHABETICAL LIST OF LOCALITIES WHERE COLLECTIONS
WERE MADE

Generally, only *Hetaerina* habitats are described for each locality, so the discussion under each locality is in no way indicative of the presence or absence of other nearby dragonfly habitats.

1. *Agua Caliente*, Guatemala, on the Rio Agua Caliente, a swift, stony headwater of the Motagua, where the railroad crosses it 20.2 miles below Guatemala City. Width about fifty to one hundred feet. Elevation about 3,200 feet. Collected June 1-2, 1909.

Along this swift and stony river were three species, *Hetaerina americana*, *cruentata*, and *macropus*. Unfortunately, my notes give no data as to the distribution of the species on the stream. All of the species are well represented in the collection, *macropus* by about as many specimens as the other two, which occurred in equal numbers.

2. *Amatitlan*, Guatemala. A town on the river draining Lake Amatitlan. Elevation, 4,212 feet. The river is clear, rapid and gravelly, and the only *Hetaerinas* seen at Amatitlan were collected on this stream. Collected June 7-10, 1909.

Of the seven specimens taken here, six are *Hetaerina americana* and the remaining specimen is *cruentata*.

3. *Aracataca*, Colombia. On the Santa Marta-Fundacion railroad, near the Fundacion terminus and about fifty-five miles from Santa Marta. Elevation probably about fifty feet. Collected at irrigating ditch near fruit company station for only a short time on January 9, 1917, and a single male of *Hetaerina caja* was taken.

4. *Arima*, Trinidad. Most of our collecting in Trinidad was done at two small rivers reached by electric lines from

Port-of-Spain and at streams crossed by the railroad from Port-of-Spain eastward to Sangre Grande. This railroad from Port-of-Spain runs nearly directly east, and not far south of the hills, to Arima, en route crossing several tributaries of the Caroni River. From Arima the railroad runs in a southerly direction for a few miles and then turns east again, which is its general direction to its terminus at Sangre Grande. From Arima to Sangre Grande it is far south of the range of hills which it skirts near Port-of-Spain, and the streams at Arima and eastward are correspondingly slower flowing. West of Arima within one mile are two small, gravelly streams, where we collected on March 4, 1912.

The streams at Arima, like the other streams east of Arima where we collected, yielded only *Hetaerina caja*. Three males and seven females were collected, indicating that we were not at the habitat where the species was most numerous and active.

5. *Aroa*, Venezuela. A terminus of the railroad, about 86 kilometers above Tucacas. Elevation, 700 feet. The sandy Aroa Valley here is dry, and the native flora is largely destroyed. Many of the surrounding hills have been burned over. At a greater distance from town are some fine rocky quebradas which rise high in the mountains and which disappear in the sand a short distance after their emergence from the hills. One of these is west of town, possibly two miles in an air line. It is two to ten feet wide, with waterfalls and deep pools and dense growths of *Cyclanthus*. About two miles west of this quebrada is another slightly larger and slower one. There is another quebrada at the Tichara mine, but it is rock-scoured, sun-exposed, and absolutely no good. Collected March 12-14, 1920.

On March 12 we collected up the quebrada two miles west of town and during the day took only one species, *Hetaerina*

macropus. The following day J. H. Williamson started collecting high up the quebrada where we had left it the day before, and near its source he collected three males of *capitatus*, the only specimens of the species taken at Aroa. We found *macropus* on all the streams. The surprising thing at Aroa was the absence of *caja*, common a few miles downstream at Boqueron and thence to the coast at Tucacas. It is probable that the streams, near the hills as they are at Aroa, were too swift for *caja*.

6. *Bejuma*, Venezuela, about 30 miles west of Valencia. Lies in a circular plain surrounded by high hills. Through this plain the Rio Bejuma meanders in a sandy or gravelly bed, shallow pools alternating with gentle ripples. Most of the valley is or has been under cultivation, and the native flora is largely gone. The stream is fifteen to thirty feet wide and bordered along much of its course with wild cane which reaches a height of twenty-five feet or more. In the surrounding hills are many small quebradas of the usual swift, rocky type, pools alternating with swift rapids and waterfalls. Plant life immediately adjacent to and in these quebradas is usually varied and luxuriant, but, on the steep hills above, the native forest is usually replaced by coffee and banana plantings. The commonest plant in the forest quebradas of Colombia and Venezuela where we have collected is a divided-leaf palm-like aquatic growing from a foot to three or four feet high among rocks in the stream. It may occur as a single plant, as small, scattered clumps, or in a continuous growth filling the stream bed for a hundred feet or more. On its leaves rest many of the dragonflies of these quebradas. From photographs and my description Mr. Ellsworth P. Killip, of the U. S. N. M., has identified this plant as *Cyclanthus bipartitus* Poit. Where these quebradas debouch from the hills

into the alley they usually meander as shallow, dirt-sided arroyos which shrink in volume before the Rio Bejuma is reached. We could not learn the elevation of Bejuma, which is probably near that of Caserio Silva, about 1,500 to 2,000 feet. Like the Rio Chirqua, the Rio Bejuma eventually reaches the Orinoco. Collected February 13-18 and 24, 1920.

Hetaerina caja was the commonest species at Bejuma and was collected every day. It occurred on the Rio Bejuma and the lower courses of the quebradas. *Macropus* occurred on the same quebradas, but higher up than *caja*, and fewer specimens were taken. Of *capitalis* only three males and one female were collected, and they were taken high up near the sources of two quebradas. These are the same three species, and the only species, taken also at Nirgua and San Esteban, Venezuela, and Bolivar, Colombia.

7. *Bolivar*, Colombia. Residence of Mr. O. L. Flye, about five miles out from Santa Marta. Elevation about 50 feet. From Bolivar the cart road has been extended about five miles farther to La Tigrera, following up the Tamacal River most of the way. This is the same Tamacal we collected at Santa Marta, but between Bolivar and La Tigrera it is a rapid, rocky stream, largely in shade, and its few permanent tributaries are of the same general character. Most of our collecting was done on these tributaries, as odonate life was not abundant along most of the course of the Tamacal, where rough and angular rocks, destitute of aquatic vegetation and washed bare by the rapid waters, offered few opportunities for aquatic larval life. The tributaries were less scoured and had occasional pools with some semi-aquatic growths. The elevation at La Tigrera is about 300 feet. Collected December 20-26, 1916.

Along the Tamacal above Bolivar *Hetaerina caja* and *macropus* were flying together, but neither species was abundant. *Caja* was not found elsewhere, excepting three males which were taken at a small pond not far from the Tamacal. *Macropus*, on the other hand, was numerous on some of the small permanent quebradas tributary to the Tamacal. Beyond the road bridge over the Tamacal above Bolivar are two such quebradas. They are three to four feet wide near their mouths and are rapid and rocky with heavy vegetation. Near the source of one of these quebradas we took a single female of *capitalis*, the only representative of the species seen at Bolivar.

8. *Boqueron*, between kilometer posts 68 and 69 on the railroad above Tucacas, Venezuela. Elevation estimated as 375 feet. Lies in a heavily wooded and flat or slightly rolling country. It is about thirty kilometers above Palma Sola, and while the flora is generally similar the greater elevation and the nearer approach to the mountains gives more variety to the topography. One result of this is that Boqueron has many beautiful streams of diverse character. South of the railroad, in a southeasterly direction, are successively the Aroa, the Chivacure and the Cabobo, the latter a larger stream than the Aroa at Boqueron. Smaller tributaries of these streams are not numerous. They may be, at this season, little isolated pools of water or, more rarely, fine, clear quebradas, with low rapids and pools and frequent growths of *Cyclanthus bipartitus* (see discussion under Bejuma). At kilometer post 70 a trail to the north leaves the railroad and, passing through forest, comes to the Rio Yumarito, a beautiful stream six to twelve feet wide, with some deep, broad pools. There are some gravelly rapids and occasional rock exposures where *Cyclanthus* grows. Boqueron is a delightful region, but we found it most disap-

pointing for collecting. In seven days we failed to add a single additional species to our dragonfly list, and in this well-watered region we found only two species of Hetaerinas. Collected March 15-21, 1920.

Hetaerina caja was the only species which we found on the main streams. On the Yumarito both *caja* and *macropus* occurred. *Caja*, which was wanting at Aroa, ten or fifteen miles away, was the commoner Hetaerina at Boqueron. At Palma Sola, below Boqueron, and where the streams were slower, *caja* was still more abundant relatively, *macropus* being represented in our collections by only two females collected there. At Caserio Silva, where the same two species, and these two only, were found, among rockier conditions, *caja* was rare and *macropus* was abundant.

9. *Caserio Silva*. A posada between Valencia and Bejuma, about seven miles out of Bejuma, Venezuela. Situated on a small, clear stream six to ten feet wide, the Rio La Mona, which is generally in the sun, but has a little native forest remaining on it. It is generally swift-flowing in a gravelly bed, with pools and ripples, but no waterfalls. Near Caserio Silva it flows into the Rio Chirgua, a stream in a deep, precipitous valley, of which the native flora has been largely destroyed. The Rio Chirgua is twenty to thirty feet wide and has pools six feet deep in it. The bed is rocky or gravelly. Its waters eventually reach the Orinoco. Elevation not known, but probably about 1,500 to 2,000 feet. Collected February 20-23, 1920.

As was to be expected from the generally swift character of the streams, *caja* was rare here and was taken only on the Chirgua. *Macropus* was much more abundant, occurring both on the Chirgua and La Mona. Our failure to get *capi-*

talis was probably due to the fact that no rocky quebrada was followed back to near its source.

10. *Chaguanas*, Trinidad. A station on the Port-of-Spain-San Fernando railroad, twenty to twenty-five miles from Port-of-Spain, lying not far from the coast in a flat country. The single small stream we found was dry in most of its course, with no flowing water. Collected March 7, 1912, and only a single female of *Hetaerina caja* was taken.

11. *Cincinnati*. Coffee estate, twenty miles from Santa Marta on Mt. San Lorenzo, Colombia. Elevation about 4,500 feet. A heavily forested region. With Cincinnati as headquarters, we collected down to 2,500 feet. Streams very numerous, about Cincinnati very rough and rocky, with some fine waterfalls. Smaller streams offered better collecting than the larger streams, and as we descended to lower levels and to the quieter streams at about 2,500 feet elevation we found odonate life still more abundant. Collected here December 28-31, 1916, and January 1, 1917.

At Rauca Pluma Creek, just below the house at Cincinnati, we found *Hetaerina capitalis* and *cruentata* common and in about equal numbers. This is at an elevation of about 4,500 feet. The stream is in forest. It has high banks, is very rocky and rapid, with an average width of four feet and a heavy flow of water. *Cruentata* also occurred in still larger numbers on two small streams, fully exposed to the sun, as a result of clearing of the forest, on the so-called upper road not far from Cincinnati and at the same elevation. At Danta Creek, also near Cincinnati, it was rare. Equally rare on the same creek were *capitalis* and *macropus*. But on the Agua Dulce, about four miles distant, and at an elevation of about 2,500 feet, *macropus* was abundant, *capitalis* was very rare, and *cruentata* was absent.

12. *Cisneros*, Colombia. Terminus of the railroad from Puerto Berrio. Elevation about 3,500 feet. Most of the native flora about Cisneros is gone and the rough, rocky streams, ten to thirty feet wide, are largely exposed to the sun. Our one day's collecting here February 10, 1917, was so unproductive that we explored only one stream, the Rio Santa Getrudis, where we took a single female of *Hetaerina macropus*.

13. *Colonia del Perené*, on the Rio Perené, Department of Junin, Peru. Elevation, 2,230 feet. At hacienda number one two streams join to form the Perené. One of these, the Rio Paucartambo, has tributaries of varied characters on the right bank just above the suspension bridge. One of these flows through scattered bushes from a boggy spot on the bank of the river. One kilometer above the bridge is a very small, rocky quebrada. Near hacienda number one is the quebrada Repressa, two to four feet wide, with many waterfalls. Near hacienda number two is a larger and slower quebrada flowing into the Rio Perené. Below and east of hacienda number one is an old river bed of the Perené, where there are large pools and a little running water, and where dragonflies were very abundant. On the road to San Juan, past hacienda number two, are some small quebradas. Collected June 4-22, 1920.

Hetaerina macropus is represented by only three males taken on the wooded part of a quebrada on the trail from hacienda number two to San Juan. On the quebrada Repressa and on the quebrada flowing into the Rio Perené near hacienda number two both *charca* and *sanguinea* were taken, but at the old river bed only *sanguinea* was found; and at the very small, rocky quebrada one kilometer above the suspension bridge and at another similar quebrada above *charca* was found. Thus

charca seems to take the place of *capitalis*, and *sanguinea* the place of *macropus* of similar Venezuelan habitats.

14. *Cristalina*, on the railroad 28 kilometers above Puerto Berrio, the latter town a river port on the Magdalena 163¾ leagues above Barranquilla, Colombia. At an elevation of about 1,050 feet, *Cristalina* lies in a rolling forested country and abounds in beautiful small, clear, gravelly streams with many ripples and a very few small waterfalls. These streams vary from a foot or two to six to twelve feet in width and all flow into the Rio Diez-y-ses, a stream of varied character, 15 to 30 feet wide. Collected here February 12-20, 1917.

Hetaerina caja occurred here only on the Diez-y-ses and on the tributary quebradas for only a short distance from their mouths. It was a little more numerous than *macropus*, which was found at the same places. *Capitalis* was rare, being represented in the collections by about the same number of specimens as *macropus*, and was taken only near the sources of the quebrada *Cristalina* and a tributary of the quebrada *Sabaleticus*. *Miniata*, on the other hand, was abundant and is represented by more than three times as many specimens as are all the other three species together. It occurred far up the quebrada *Cristalina* and throughout its course, as well as at its mouth, where, and on the Diez-y-ses, it was associated with *caja* and *macropus*. On the larger part of the quebrada *Sabaleticus*, a beautiful gravelly stream six to twelve feet wide, in original forest, with long pools and ripples, it occurred in great numbers, without other *Hetaerina* competitors. It was also abundant and was the only *Hetaerina* taken on the quebrada *La Camelia*, after a short distance above the mouth.

15. *Cumuto*, Trinidad. On the railroad between Arima and Sangre Grande. The stream here, a tributary of the Caroni, is in sand and gravel, clear, with low, short ripples.

See under Arima. Collected March 6, 8 and 10, 1912.

At Arima and at the stations east of there where we collected there is but one species, *Hetaerina caja*.

16. *Cunapo River*, near Sangre Grande, Trinidad. A slow-flowing stream, eight to ten feet wide, with clay bottom. A tributary of the Oropuche River, flowing to the east, and opposite the westward-flowing Caroni. Collected here February 27, 1912.

Hetaerina caja was abundant on this stream, and associated with it we found a single female of *macropus*.

17. *Diego Martin River*, Trinidad. A stream at the end of the Four Roads electric car line from Port-of-Spain. A fine stream which we collected from Blue Basin to the car line. Collected February 29 and March 3, 7 and 10, 1912.

Most of our collecting on the Diego Martin was within a mile of the car line, where we found only *Hetaerina caja*. On March 3 we went to Blue Basin and collected down-stream to the car line, and it was on the upper part of the stream, and there only, that we found *macropus*.

18. *Don Jaca*, Colombia. A clear, rocky stream about 10 to 15 feet wide, widely exposed to the sun, on the railroad about 25 kilometers from Santa Marta. Elevation probably about 50 feet. Between kilometers 17 and 18 is a small stream in sand. Collected these two streams December 17, 1916.

Odonate life was not abundant on either of these streams. On both the only *Hetaerina* collected was *caja*.

19. *El Banco*, on the Magdalena and Cesar rivers about 86 leagues above Barranquilla, Colombia. At the season we were there there was no flowing water near town except the rivers. Along the isolated pools of a wet weather stream in a forest strip surrounded by a dry, treeless plain we found a few species of dragonflies, some in large numbers, but *Hetae-*

rinas, as was to be expected, were very scarce. Collected here January 23, 1917, taking only a male and a female of *Hetaerina caja*.

20. *El Fiscal*, Guatemala. Still higher headwaters of the Motagua above Agua Caliente and 12.7 miles below Guatemala City. Small, rocky streams in deep ravines. Elevation about 3,700 feet. Collected June 3-6, 1909.

Along the so-called river north of town, on June 4, *Hetaerina capitalis* (thirty-seven specimens), *cruentata* (fourteen specimens, and *macropus* (two specimens) were taken. *Macropus* was seen nowhere else. On the stream south of town along the government road only one species, *cruentata*, was taken, and of it only two specimens. On June 6 I collected again on the river north of town, but higher on the stream than on my previous visit. On this upper portion I failed to find *macropus*, taken lower down, and *cruentata* was five times as abundant as *capitalis*, while lower down *capitalis* had been more than twice as abundant as *cruentata*.

21. *El Guayabo*, Venezuela. A station on the Gran Ferrocarril del Tachira, the railroad from Encontrados to Tachira, and on the banks of the Rio Zulia. Elevation, 225 feet. El Guayabo lies in a wide, flat, wooded valley, most of which near town is pasture or under cultivation. This valley extends northward, without interruption and with a progressively lower elevation, till it passes almost imperceptibly into Lake Maracaibo. On the left bank of the Zulia opposite the town are sluggish tributaries with little flow except when they discharge the backed-up waters of the Zulia when the latter falls after a rise. About six kilometers above town on the right bank, and crossed by the railroad, is El Caña Fraile, six to fifteen feet wide, in forest. On April 20 it was a succession of pools. On April 22, the Zulia having risen in the

meantime, the Fraile was a mill-race-like stream, flowing *away* from the Zulia to some inland lake or swamp. Seven or eight miles east of town, in the forest, we found nearly dry and very muddy remains of other such cañas leading away from the river. Collected April 20-22, 1920.

On the Fraile, both before and after the rise of water in it, and on the cana in the forest east of the town we found a few specimens of *Hetaerina caja* and *miniata* flying together, the former about five times more numerous than the latter.

22. *Fundacion*, Colombia. End of railroad from Santa Marta. Elevation about 50 feet. Rio Fundacion here is a wide, shifting, sand-bottomed river. Irrigating ditches from the river furnished the only other running water at that season. Above town about two miles, on the left bank of the river, was a large, nearly dry and very muddy creek or arroyo with widely-separated pools of stagnant water eight to ten feet wide. Here, associated with *Perithemis* and *Acanthagrion*, we collected the only *Hetaerina* seen at Fundacion, a few specimens of *caja*. Collected at Fundacion January 9-14, 1917.

23. *Gualan*, Guatemala. A station on the railroad 80.2 miles above Puerto Barrios. Elevation, 420 feet. The Gualan River here is a clear, gravelly stream one hundred feet or more in width. Just above the railroad bridge is a small, gravelly tributary of the Gualan. A similar, smaller but more shaded stream is in the forest about a mile and a half below town. Opposite Gualan is the Rio Manuel, a tributary of the Motagua, from which the city derives its water supply. My notes are deficient, but as I recall it the Rio Manuel is fifteen to thirty feet wide, and is a rapid-flowing hill stream. Like the Gualan River, it was not rich in odonate life. Collected June 11-18, 1909.

This is the lowest elevation I have for *Hetaerina americana* in the Motagua drainage, and the highest station for *titia*. The former species is represented by a single male taken on the Gualan River. The same day twelve *titias* were taken along the nearby tributary of the Gualan, and the same small stream yielded forty-four specimens of *macropus*. At the small stream, a mile and a half below town, *macropus* and *titia* were again associated, again *macropus* being the more abundant in about the ratio of eight to one. Both species also occurred in limited numbers along the Rio Manuel or some of the artificial streams diverted from it.

24. *La Fria*, Venezuela. A station on the railroad above El Guayabo. Elevation, 460 feet. *La Fria* lies at the edge of the hills in the valley which extends northward to Lake Maracaibo. The forest is heavy mixed growth, and north of town, where we explored it for miles, it was nearly flat, with occasional small and very muddy, swampy spots, but with no flowing water. East of town, and crossed by a spur of the railroad, is a sandy quebrada, eight to ten feet wide, with a good flow of water, which, however, disappears in the sandy soil a few miles north or northeast of town. The old stone road south of town goes back among the hills, and about two kilometers from town it crosses the beautiful little quebrada *La Fria*, which in its lower course, near the stone road, is a gently flowing stream, five to ten feet wide, of sand, gravel and boulders. Growing in the stream were many plants of a calla-like arum. About a kilometer and a half beyond the quebrada *La Fria* the road crosses the slightly larger quebrada *Santiaquita*. This quebrada, possibly a kilometer below the stone road, meets with another and slightly larger stream. These streams were very similar to the fine little streams about *Cristalina*, Colombia, except that possibly there were

more rocks in the La Fria streams, especially in their upper courses. Collected April 12-18, 1920.

Hetaerina caja, not known on the swifter streams a few miles above at Tachira, was present, but rare, at La Fria, where it was taken on the sandy quebrada east of town and on quebrada La Fria, a total of ten specimens altogether. *Macropus* was still rarer, with a total catch of three specimens on quebradas La Fria and Santiaquita. *Miniata* was the abundant *Hetaerina* at La Fria and was taken every day we collected there, except one day when our entire party was in the streamless forest north of town. The rarity of *macropus* was a great surprise, as it was abundant at Tachira, and the swifter streams at La Fria seemed well suited to it. Below La Fria, at El Guayabo, *macropus* had entirely disappeared, but the character of the streams there was such that this is what one would expect.

25. *Los Amates*, Guatemala. A station on the railroad 59.3 miles above Puerto Barrios. Elevation, 160 feet. Rio San Francisco, below town, is fifteen to twenty feet wide, sluggish, with generally overhanging banks and few beaches. Easily waded in low water stage on June 19, but wading difficult or impossible following heavy rains that night. After these rains a small wet weather stream with abundant odonate life made its appearance in the forest on the east of the railroad below the Rio San Francisco. Collected June 18-22, 1909.

On June 19, collecting from the railroad bridge over the San Francisco up-stream a mile or more, I took three *Hetaerina macropus*, two *miniata*, and forty-six *titia*. *Macropus* was also collected along the wet weather stream east of the railroad.

26. *Macuto*, Venezuela. About a mile and a half east of La Guiara. The Rio Macuto at Macuto is a clear, swift,

rocky stream, about ten feet wide, flowing directly into the Caribbean Sea. Collected January 28-30, 1920.

The only species taken on this fine little stream was *Hetaerina macropus*. The absence of a coastal plain explains the absence of *caja*, and the absence of *capitalis* from our list is probably to be explained by our failure to reach the higher sources of the stream.

27. *Maracas River*, near St. Joseph, Trinidad. We collected from the Maracas Fall, 340 feet high, down-stream several miles. The upper part of the stream is swift and rocky; the lower part, swift but slower, and gravelly. Collected March 5, 1912.

Hetaerinas were rare here, and we took only two specimens of *caja* and three of *macropus*. This, of all the places we collected in Trinidad, was the most likely-looking for *capitalis*, but though we failed to find this species in the island, it is not impossible it may yet be found high in the hills above any of the stations visited by us.

28. *Maraquita*, Colombia. On the railroad above Honda. Elevation about 1,500 feet. Many fine streams are near town. Some of these are rocky and swift, with high waterfalls and steep, wooded banks. Others are generally swift, but with much sand and without waterfalls. They vary in size from tiny brooks to streams 30 to 40 feet wide. As usual, the smaller streams were richest in dragonflies. Collected here February 3-5, 1917.

The Maraquita water supply comes from the San Juan River. The intake is just above a high waterfall. Above the intake the stream is three to six feet wide, very rocky, with some high waterfalls. Its banks are high and steep, with many heliconias and large bamboos near the water, and high trees. Along this upper stretch of the river we found *Hetae-*

rina macropus and *capitalis* common, and *miniata* very rare. Below the intake *capitalis* was not found, but *caja* appeared commonly there, *macropus* was in smaller numbers, but still common, while *miniata* was very rare.

On the Poquera River, south of town, we found only *caja* and *macropus*, both common and in about equal numbers. The Poquera at this date was five to fifteen feet wide, in a wider, more sun-exposed bed than the San Juan. The water was low when we were there, and we were told that it sometimes became entirely dry.

29. *Morales*, Guatemala. A station on the railroad 33.6 miles above Puerto Barrios. Elevation estimated at about 100 feet. A large, sluggish stream here was too deep and with banks too brushy for effective collecting, and the only Hetaerinas taken were five specimens of *titia*. Collected May 27, 1909.

30. *Nirgua*, Venezuela. Conditions similar to Bejuma, but the country rougher and, adjacent to the town, more despoiled. The Rio Borria, at the foot of the plateau on which the town is built is eight to twenty feet wide, and a few miles above town is in such a deep, rocky gorge with high waterfalls and deep pools that it is impossible to follow the stream. Above the intake for the city water supply, where it flows through brush and small trees, the stream is six to twelve feet wide and is gravelly and not very swift. Three or four miles north of town is a typical hill quebrada in pastures, brush, and coffee and banana plantings. On the top of the hill, above running water, is a humid forest. A similar small quebrada is about four miles northeast of town on the road to Bejuma. Elevation of Nirgua not learned, probably 1,500 to 2,000 feet. Collected February 25-29, 1920.

On the Rio Borria and the two quebradas, both *Hetaerina macropus* and *caja* occurred, in every case *macropus* being the more abundant. High up the quebrada north of town a single male of *capitalis* was taken.

31. *Palma Sola*, Venezuela. At kilometer post 37 on the railroad above Tucacas. Elevation, 120 feet. Lies in a nearly flat, heavily wooded country. The Aroa River here is a swift, generally shallow stream, fifty to sixty feet wide, bed largely sand and the banks adjacent to the stream generally covered with wild cane. Three or four miles above Palma Sola there is a right-hand tributary of the Aroa which is eight to ten feet wide and which, in its characters, is merely a miniature Aroa. In the forests about Palma Sola are the remains of several wet weather streams of considerable size. There are pools of water two to ten feet wide and three to one hundred feet long, generally with little or no flow of water between pools. The stream beds are generally sandy, though some are muddy where there are extensive heliconia growths. Collected March 4-10, 1920.

As might be expected, this region is not rich in Hetaerinas. At a sluggish quebrada about one kilometer north of town we found *caja* common, and on the same quebrada took two specimens of *macropus*, the only specimens of the latter species seen at Palma Sola. *Caja* was taken also on the Aroa, on its tributary of similar character, and on an almost dry quebrada crossed by the railroad to San Felipe about five kilometers out from Palma Sola.

32. *Puerto Barrios*, Guatemala. Near sea level. Small, sluggish and brackish streams are reached by following the railroad track back from the coast. One stream, the first one above the roundhouse, was fresh (May 28) about half a mile

above the railroad, but brackish below that point. Collected May 25-30, 1909.

At this small stream *Hetaerina titia* was very common, more frequently over fresh water, but observed also over nearby brackish water. On a stream farther up the railroad track, which was entirely brackish where we explored it, no *Hetaerinas* were seen. On the stream where *titia* was common two specimens of *miniata* were taken. No others were seen.

33. *Rio Frio*, Colombia. On the railroad about 48 kilometers from Santa Marta. Elevation probably about fifty feet. A fine, clear, swift stream, the Rio Frio, 40 to 60 feet wide, crosses the track here. At this season it could be waded. Trees grew to the water's edge. Back of Esperanza Farm is the quebrada de Calabacito, which disappeared in the lowlands, but back in the hills was a stony stream of running water with pools six feet wide and ten to twelve feet long, with about two feet as a maximum depth. Streams were generally absent at this season in the semi-arid chaparral, but irrigating ditches to a certain extent took their place. Collected January 6-8, 1917.

On the quebrada de Calabacito we found both *Hetaerina macropus* and *caja*, the former twice as numerous as the latter, but neither abundant. On the Rio Frio also both species occurred rarely, but here *caja* was more numerous than *macropus*. On a large irrigating ditch we found only *caja*, which flew there in large numbers.

34. *Rio Mazamba*, and

35. *Rio Sardanilla*, two small streams, crossed by the railroad. Canal Zone, Panama. The Rio Mazamba was collected December 6, 1916, only in its lower part near the railroad; but the Rio Sardanilla was followed on December 5, 1916,

far back into the hills, where it is a beautiful little stream flowing in a rocky and gravelly bed, with pools and waterfalls.

On the Rio Mazamba, where we spent only a short time, and that only on its lower courses near the railroad, we took only *Hetaerina caja* and *miniata*, the former common, the latter represented by a single specimen. On the Rio Sardanilla, where we collected more carefully, we found a *Hetaerina* fauna very rich in species, if not in individuals. On not to exceed two or three miles of its course we took nine *Hetaerina caja*, five *fuscoguttata*, eleven *macropus*, and one *miniata*. Unfortunately, we failed to notice if there was any particular distribution of these species on the stream.

36. *Rockstone*, on the Essequibo River and on the Wismar-Rockstone railroad, British Guiana. Elevation not noted. Just east of the hotel is a large log-jammed creek, fifteen to twenty feet wide in low water. A short distance below the railroad station is a small, muddy creek, nearly dry, a succession of stagnant pools with no running water. On the large island in the Essequibo opposite Rockstone is a similar but drier muddy creek bed. Collected February 1, 2 and 14, 1912.

Hetaerina dominula was taken on the large creek just east of the hotel and nowhere else. Only fourteen specimens were taken. A few *laesa* were collected on the small creek below the railroad station, and a larger number on the island, where also the single specimen of *moribunda* taken at Rockstone was found. *Hetaerinas* were rather rare at Rockstone, our total catch numbering only thirty-six specimens.

37. *Salom*, Venezuela. A town on the road from Bejuma to Nirgua. Conditions similar to those at Bejuma. Collected the small, sandy and gravelly river near town for a few hours on February 25, 1920. The water of this stream eventually finds its way to the Orinoco.

The to-be-expected *Hetaerina caja* and *macropus*, three specimens of each, were collected here.

38. *San Esteban*, Venezuela. A village on the Rio San Esteban about six miles back of Puerto Cabello. The Rio San Esteban is a clear, swift, rocky mountain stream, except near its mouth below San Esteban, where it flows for several miles through a nearly level sand plain. Above San Esteban the valley is narrow, the bed of the stream is rock or coarse gravel, and there are many waterfalls. Below San Esteban the stream is largely in the sun. Above San Esteban almost the entire valley is wooded, with much coffee and cacao on the main stream and more native forest on the higher quebradas. Many tributaries (quebradas) are encountered as one ascends the Rio San Esteban, and these are even rougher and more precipitous than the main stream. The length of the quebradas we explored between San Esteban and Las Quiggas, a village on the Rio San Esteban above San Esteban, from their sources in the hills to their mouths in the main stream, varied from less than a mile to possibly four or five miles. We could not obtain elevations at San Esteban, but our collections were made from nearly sea level up to possibly 2,000 or 3,000 feet at the heads of the highest quebradas. Collected here February 1-9, 1920.

Below the village of San Esteban we followed down the Rio San Esteban for possibly three miles. Throughout this course the stream is largely in cacao plantings. Near the village *Hetaerina caja* and *macropus* were associated, but farther down *macropus* disappeared and we found only *caja*. High up on a quebrada on the left bank of the Rio San Esteban, just above the intake dam above the village of San Esteban, we found *capitalis*. It was most numerous near the source of the quebrada, and as we came down-stream it was rarer and

was associated with *macropus*. It disappeared about a mile below where we first found it. We found it again under similar circumstances on a right-hand tributary quebrada just above Las Quiggas. *Macropus* occupied the streams between the habitats of *capitalis* and *caja*, overlapping where their habitats came together. It was the most abundant and widely distributed of the San Esteban Hetaerinas. On the rocky quebrada on the left bank of the Rio San Esteban, opposite the old Salom home, we were surprised to find no Hetaerinas.

39. *San Felipe*, Venezuela. Elevation, 745 feet. The town lies in the broad, alluvial plain of the Yaracuy River. All the stream beds about San Felipe were dry except the nearby mountain quebradas and a few small, short spring streams. The quebrada from which the city derives its water supply is open, rocky, swift and bed-scoured. We found it impossible to follow the stream after a short distance above the intake because of the precipitous sides and deep pools. Collected March 2 and 3, 1920.

Only a single specimen of *Hetaerina caja* was taken here, but *macropus* was common on all the streams.

40. *San Juan River*, near San Juan, Trinidad. A gravelly stream with some boulders, swift-flowing. Collected March 2, 1912.

Hetaerina | *caja* and *macropus* were both common on this stream, the former twice as numerous as the latter.

41. *San Pedro Sula*, Honduras. Estimated elevation about 250 feet. The city lies in a broad valley, with the nearest hills about two miles south of town, where a small woodland ravine stream flows from the hills into the valley. Along this small stream occurred the richest Hetaerina fauna I have seen. Collected February 26-28, 1905.

I noted of *Hetaerina cruentata* that it occurred along the stream where it emerged from the hills, but whether or not it also ranged back into the hills my notes do not show. It was back in the hills that I found *macropus*, *miniata* and *capitalis*, but again my notes fail to show if there was any local distribution of these species on the stream. The following numbers of specimens of each species were taken and will indicate in a general way their relative abundance: *cruentata* 46, *macropus* 10, *miniata* 123, *capitalis* 9.

42. *San Ramon*, Department of Junin, Peru. Elevation, 2,800 feet. One kilometer from San Ramon, across the Rio Chanchamayo, is a small, sandy-bottomed creek one to two feet wide, flowing through cleared land and banana plantings. Near San Ramon is the small quebrada Apurimae, flowing through open country in corn and bananas, with bushes on the creek's bank. The creek bed is mud, sand and boulders. Collected July 12-15, 1920.

Hetaerina sanguinea was the only species observed on these streams.

43. *Santa Marta*, Colombia. On the coast. The Manzanares River and its tributary, the Tamacal, were here largely exposed to the sun and flowing generally over beds of fine sand. Collected here December 13-19, 1916, and January 3, 1917.

Three specimens of *Hetaerina macropus* were taken along small streams in a woods along the railroad track and adjacent to the Tamacal. Everywhere else the only species found was *caja*, which was common.

44. *Santo Tomás*, Guatemala. On the coast. Near town a large spring forms a pool of water at the foot of a hill. From this spring a short stream flows into the nearby gulf. Collected May 29, 1909.

On this small stream I collected one specimen each of *Hetaerina macropus* and *miniata*, three of *pilula*, and six of *titia*. Larger series might have been collected, but I spent most of my time at the pool collecting dragonflies of other genera.

45. *Sevilla*, Colombia. A station on the railroad between Santa Marta and Fundacion. Elevation probably about 50 feet. Collected here only about an hour along an irrigating ditch, on December 15, 1916, and took five specimens of *Hetaerina caja*.

46. *St. Ann River*, Port-of-Spain, Trinidad, reached by the St. Ann street car line. Above the car line about a mile the stream is very rocky and swift, with only a few species of dragonflies. Collected March 1, 1912.

Hetaerina macropus was more abundant on this stream than on any other stream we collected in Trinidad, and it is the only stream, where Hetaerinas occurred at all, on which we failed to find *caja*.

47. *St. Joseph River*, near St. Joseph, Trinidad, on the railroad between Port-of-Spain and Arima. Stream similar to the San Juan, eight to twelve feet wide, swift, gravel and rounded stones, with some long, swift ripples. Collected February 28 and March 11, 1912.

Hetaerina caja and *macropus* were common here, the former about five times more numerous than the latter.

48. *Tachira*, Venezuela. Terminus of the railroad from Encontrados on the Catatumbo River. Elevation about 1,200 feet. Tachira lies on the mountains back of La Fria where the hills first begin. It is in a heavily wooded region of steep or precipitous mountain sides with many streams. In the deeper valleys are swift streams fifteen to thirty feet wide, with pools and many rapids, but no waterfalls. The beds of

such streams are wide and exposed, and odonate life is rare on them. Two of these streams are the Rio Lobaterita, on the west side of town, in a deep valley, and the Rio Uraca, which the railroad crosses about a mile below town. Tributary to these streams are small quebradas of various characters. Some are miry, sluggish streams with only a small flow of water. Other quebradas are rocky, with waterfalls six to ten feet high. More rarely there are tributaries of an intermediate character, where the fall is about three to fifteen feet in the hundred, with frequent little waterfalls. In such a quebrada the stream bed is usually small, rounded boulders, with some gravel. Collected April 4-11, 1920.

Along the Rio Lobaterita were frequent diversions from the main stream, forming little streams which soon again joined the larger volume of water. At these places and about the mouths of small tributary quebradas *Hetaerina macropus* flew in limited numbers. On a very rocky tributary, three to eight feet wide, with only a small flow of water, but many pools and waterfalls, *macropus* was associated with *capitalis*, both rather rare, and *macropus* about twice as abundant as *capitalis*. *Miniata* was not seen on this stream. On a somewhat similar but flatter quebrada with more vegetation, which flowed through town, and which we collected from the road bridge far toward its source, *capitalis*, *macropus* and *miniata* were present and numerous and occurred in about equal numbers. On quebradas which the railroad crossed just below town *macropus* and *miniata* were common in about equal numbers. Along a small, short, muddy quebrada through brush and heliconias in the river bottom of the Rio Lobaterita, the three species, *capitalis*, *macropus*, and *miniata*, occurred, but the first two were rare, in about equal numbers, while *miniata* was about four times as numerous as the first two together.

On tributary quebradas of the Rio Uraca, a beautiful stream above the railroad bridge, we found *capitalis* and *miniata* in about equal numbers, and *macropus* about twice as numerous as the other two together. These quebradas were of the intermediate type described in the last two sentences of the preceding paragraph.

49. *Tucacas*, Venezuela. On the coast. Terminus of the railroad, which has three inland termini, San Felipe, Aroa and Barquisimeto. Back from the town is a small, boggy stream three to six feet wide and one to three feet deep, sides steep or overhanging, from which the town receives its water supply. Adjacent to the stream were literally thousands of spider lilies (*Crinum*) in bloom and there were many wet patches of heliconias. Dry woods and dry heliconia patches were adjacent and gave evidence of flooding during the rainy season. The lower part of the stream is shallower, broader, and sandy or gravelly, with a few low ripples. Collected March 23-25, 1920. A few *Hetaerina caja* were taken here.

50. *Tumatumari*, on the Potaro River, about seventy-five miles above Rockstone, British Guiana. Elevation not noted. Country hilly and heavily wooded. Above town on the right bank is a small, sluggish stream, known as Cashew Creek, two to six feet wide, with a mud bed. A similar stream with less flow of water is on the left river bank below the falls in the river. A trail from Tumatumari leads back into the forest and about four or five miles from town crosses Tiger Creek, a sluggish stream almost too large to wade. Further up-stream there is a large waterfall in Tiger Creek known as Washerwoman Falls. The trail from Tumatumari to Tiger Creek crosses a few little streams from a few inches to as large as three feet in width. They are generally muddy and some of the smaller ones lose themselves in the forest. One of these

streams, about three miles out from Tumatumari, was followed to its mouth in Tiger Creek. Collected February 5-13, 1912.

Hetaerinas were rare about Tumatumari, the total capture amounting to only sixty-seven specimens, thirty-six of which were *dominula*. On Cashew Creek we took *dominula* and *moribunda*, each represented by two specimens, and *mortua*, represented by a single specimen. On the first small creek out from town on the Tiger Creek trail we collected four specimens of *dominula*, and on the creek on the left bank of the river, below the falls, we found *dominula*, *laesa*, *moribunda* and *mortua*, the first represented in the collection by thirty specimens, the next two by one specimen each, and the last, *mortua*, by twenty-six specimens.

51. *Wismar*, on the Demerara River, sixty-two miles above Georgetown, British Guiana. Elevation not noted. Some small, muddy creeks tributary to the Demerara adjacent to town, easily waded earlier in the day, are so backed up with water in the late afternoon, due to the tides, that the collector finds them impossible to work. There is a small wooded creek south of town and a smaller swamp one, rising in some low hills, just west of town. Below town the footpath to Christianburg crosses a muddy, log-filled creek. At Christianburg there is a small, muddy creek in the brush parallel to and near the left bank of the canal. Collected January 30 and 31 and February 15 and 16, 1912.

Only two specimens of *Hetaerina moribunda* were taken at Wismar, and our notes are not clear as to exact location. They were taken either on the small creek south of town, or, less probably, on the smaller creek west of town. *Dominula*, on the other hand, was common and was taken on both the streams mentioned in the preceding sentence and on the stream along the canal at Christianburg.

