Project Update: April 2019

This project has two main areas, the social and the ecophysiological. In the social area we proposed two main activities: weekly environmental workshops with the community from August to December and the painting of a mural which celebrates the biological richness and the history of the region. In the ecophysiological area we proposed to measure the oxygen consumption of larvae and adults of dragonflies and damselflies at different temperatures along the Tatamá elevation gradient.

Community workshops

Since the second week of September 2018, we held 16 workshops, principally with kids 5-12 years old. In some of the workshops we also had the company and help of the adults of the environmental group "ASOAFA"; we had an average assistance of 15 kids, and we managed to engage them in the workshops with a continuous assistance of the whole group (Figure 1). We managed to work on all the subjects proposed but we had to devote more time to some subjects which are the pillars for understanding the great richness they have in their region, so we sacrificed time in the ecotourism workshops and devoted it to the concepts of biodiversity, niche, conservation, and ecosystem services (principally teaching the water cycle and the soil nutrient cycle, Figure 1). At the end of the workshops we prepared a play about the water cycle which was the topic chose by the kids to share with their families. During the second week of December 2018 we concluded the workshop cycle with a meeting with the kid's families and the presentation of the play (https://www.youtube.com/watch?v=MOXVKw2zprE).

Figure 1. *Some of the images captured during the workshops, it can be observed the work with birds and aquatic macroinvertebrates as models to understand the niche concept. Also the kids happy with their paintings on ecosystem services and the material we prepared for the play.*

Murals

We painted two murals, one in the school of and Embera indigenous village and one in the Santa Cecilia main square. The group of artists (Colectivo de ilustración BioGrafos) who collaborated in the paintings came from Manizales and Medellin, two capital cities in the Andean region, the trip allows them to interact and learn a lot of the cultures in the area which we try to reflect in the murals.

The mural in the Embera village school was made quickly; we just had one journey to go there visit their village and paint the mural. We tried to represent some of their typical food as the "Sabaletas" (fish), "Primitivo" (a small variety of plantane), "Guagua" (*Aguti paca*, a big rodent which is their most appreciated hunting prey), and "maíz" (corn). Also we wanted to make a tribute to their singular art style so we paint geometric patterns with vivid colors similar to what they use for necklaces and earrings. In the middle of the mural we wrote the Embera word for learning *"ESEAY"* and invited the children who bring joy to us with their plays and

jokes during the journey to print their hands in the mural (Figures 2-3).

***Figure 2: a**, the school before the mural; **b-d**, development of the mural, the participation of some Embera kids can be observed.*

***Figure 3: a**, the Embera kids printing their hands on the mural; **b**, the mural finished; **c**, the whole crew after a hard day of work with the Western Cordillera foothills at our backs.*

The mural in the main square of Santa Cecilia was more complex, it took us 6 days of work beginning with the sketch and becoming a very interesting exercise who was enriched thanks to the attention of the community who offered us help in

many ways, they participated through ideas for the mural, they also helped us painting and bringing a lot of joy with jokes, dance, compliments and even ice cream (https://www.youtube.com/watch?v=e4SbPSGsXHs).

We decided to tell the history of Santa Cecilia without the illustration of any humans; we have a scene in the middle of the mural which shows an image of how we imagine the region two centuries ago, with very emblematic animals as the "jaguar" (*Panthera onca*), a poisonous frog (*Oophaga histrionica*), a fish regularly present in their meals "Guacuco" (*Chaetostoma* sp.), the "Maestro" the biggest damselfly in the world which is known to visit the fallen trees, even the logged ones (*Megaloprepus caerulatus*), and a crab (Pseudotelphusidae). Then a ring with geometric patterns as the ones used by Embera people and filled with the most representative plants in the region separates this epoch from the colony which is represented with the bars of the prison which was the main reason of Spaniard descendants to come to the region "Cinto`s prison".

Among the plants represented are: "Caimito" a tree with sweet and juicy fruits (*Pouteria caimito*), "Borojó" one of the tastiest fruits endemic from the biogeographic Chocó region (*Borojoa patinoi*), "Maíz" one of the principal sources of carbohydrates (*Zea mais*), a bromeliad showing the richness in ornamental plants, "Chontaduro" a palm which fruits trade was one of the main economic incomes in the region until past decade (*Bactris gasipaes*), "Ñame" a tubercle brought from Africa (*Dioscorea alata*), "Lulo chocoano" probably a variety of *Solanum quitoensis*, "cacao" the chocolate three (*Theobroma cacao*), "Achin" the stem of an arum brought from Asia which taste similar to potatoes but is very rich in calcium (*Colocasia esculenta*), "piña" the famous pineapple (*Ananas comosus*), "yuca" a native tubercle rich in carbohydrates (*Manihot esculenta*), "Platanos" plantanes a delicious plant brought from Africa (*Musa paradisiaca*), and the "Árbol del pan" brought from Asia (*Artocarpus altilis*). In the colony epoch six animals are represented: the ornate hawk eagle (*Spizaetus ornatus),* which is the biggest eagle that inhabits the region now, after the logging of most of the biggest trees, the spider monkey which become rare and can only be found in the most step areas of the forest in modern times (*Atteles fusceiceps*), the Baudo Oropendola, an endemic bird which is endangered by the quick loss of its habitat (*Psarocolius cassini*), a horse fly, which ancestors probably made the life of the prisoners at Cinto`s prison miserable and now keep biting us, a bee (*Apis melifera*) one of the most important insects for ecosystems which is going through a pretty bad crisis worldwide, and a hunting dog, brought here by the first afrodescendents who scape from slavery and become the most appreciated domestic animal in the region. Then two snakes divide the colony epoch from the modern epoch represented by the road. The snakes are the "Mapana or Talla X" (*Bothrops asper*) which is the most common viper in the region and the responsible of most of the ophitic accidents and the "false coral" (*Rhinobotryum bovalli*) a colubrid which mimics the very venomous coral snakes. In the road we can observe the weevil *Rhynchophorus palmarum* which during the last decade killed most of the Chontaduro palms making the principal product of the region disappear, we painted a rifle and a small cross at the side of the road recalls of the violence wave that beat the region, and we painted the two technologies that made possible the quick modification of the landscapes close to the road: the trucks and the shine saws. All these immersed in the great biological richness that the region still harbors represented by some flowers and leaves as: the orchids *Oncidium*

fuscatum and *Pescatoria* sp., the "Platanillo" (*Heliconia* sp.), the palms *Geonoma* sp. and *Iriarthea* sp., the bush *Bellucia* sp., *Piper* sp., the epiphytes *Asplundia* sp., *Anthurium* sp., a Gesneriaceae (*Chrysothemis friedrichsthaliana*), and a fern (Figures 4-5).

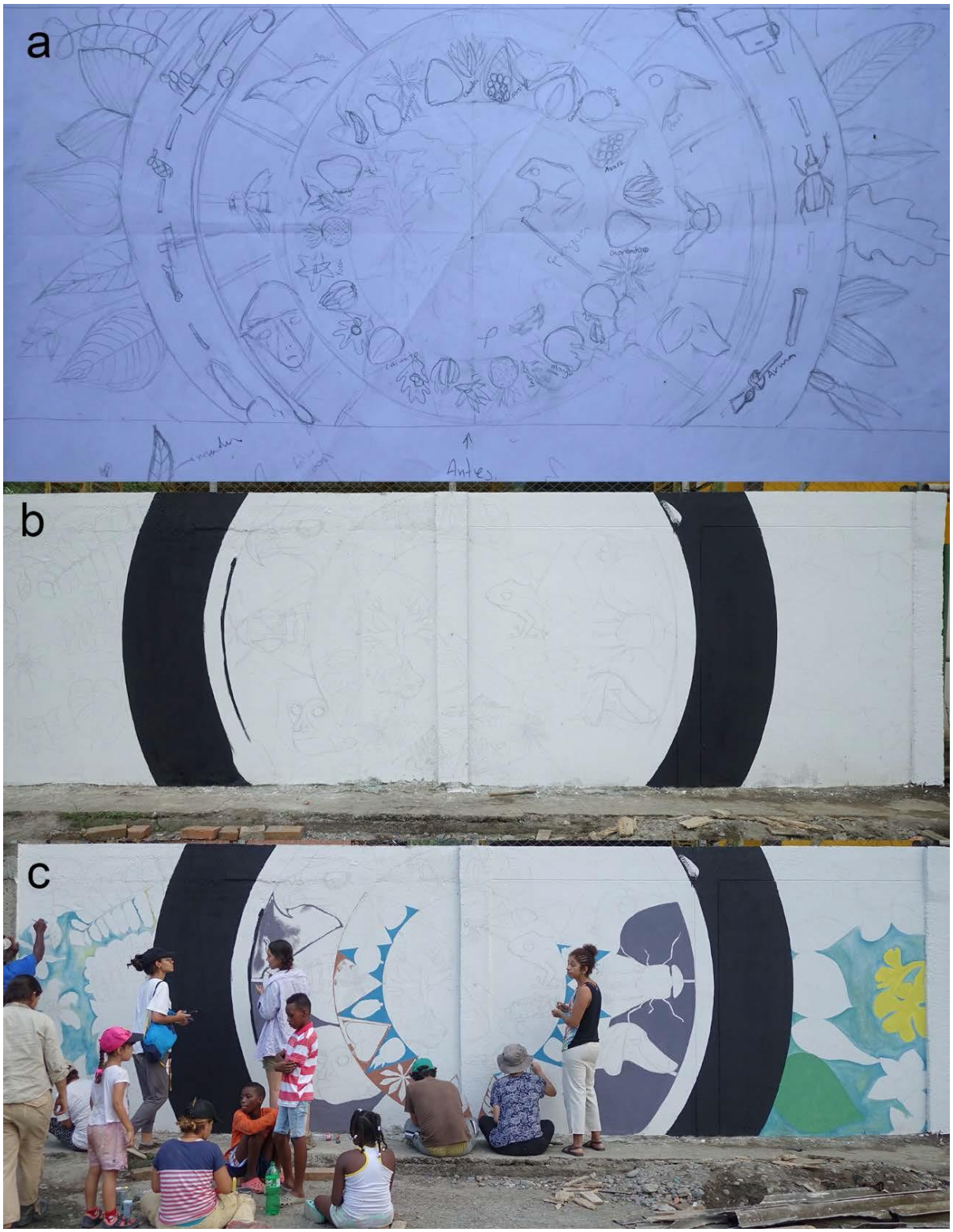

Figure 4: a, *Sketch;* ***b,*** *sketch on the wall;* ***c,*** *the beginning with the contours and backgrounds.*

Figure 5: a-c *the progress of the mural during the week the participation of the community can be noticed in a and b;* ***d,*** *the final mural and guys of BioGrafos illustration collective.*

Measurements of dragonfly oxygen consumption

We decide to concentrate the efforts working on five genera which have wide elevation distribution but different niche, behavior, and evaluative history, so the

comparison between these species thermophysiological adaptations are of much interest, they are: *Argia, Erythrodiplax, Hetaerina, Heteragrion,* and *Macrothemis* (Figure 6).

Figure 6: a, *Argia indicatrix in copula;* ***b,*** *Erythrodiplax andagoya male;* ***c,*** *Hetaerina occisa male;* ***d,*** *Heteragrion mitratum in copula;* ***e,*** *Macrothemis hahneli female.*

Argia is the most diverse genus of odonates in America, it is part of the family Coenagrionidae and are small damselflies, in this project we are working with

three species of wide altitudinal distribution: *A. indicatrix* (0-1500m), *A. medullaris* (1100- 2600), and *A. oculata* (0-1500m). These three species differ also in the habitat used with *A. oculata* been more common inside forest and its edge and *A. indicatrix and A. medullaris* are more common on open areas and also the edge of forests.

Erythrodiplax is a genus of the family Libellulidae, four species are common in the Tatamá elevational gradient *E. abjecta* (1300-2600m), *E. andagoya* (0-700m), *E. fusca* (0-1500m), *E. ines* (0-1500m), they share the same habitat ponds and wetlands in open areas.

Hetaerina is a genus on the family Calopterygidae, all the species breed in running waters but they present niche differentiation, *H. miniata* is the only species below 300m, it inhabits all kind of running waters from rivers to creeks inside forest in the lowlands, in the foothills *H. occisa* is present in all kind of running waters outside the forests, *H. caja* is found in bigger rivers in the forests and *H. capitalis*prefers streams and creeks in the forests, up the mountain *H. caja* is replaced by *H. aurora,* and *H. occisa* is replaced by *H. cruentata.*

Heteragrion is a genus in the family Heteragrionidae, all the species breed in small rivers, streams, and creeks inside the forests in the Tatamá elevational gradient six species are recorded but only four of them are common *H. aequatoriale* (900-1600m) in small rivers and big streams, *H. erythrogastrum* (0-200m) in all kind of running waters, *H. mitratum* (300-750m) streams and creeks, and *H. tatama* (1300-1750m) in creeks and small streams.

Macrothemis is a genus of the family Libellulidae, it differs from the other genera studied on its behaviour since these dragonflies fly most of the time (the others perch most of the time), none of the species of the genus present on the Tatamá altitudinal gradient has a wide elevation distribution, but we find species from the lowlands to the mountains: *M. musiva* (0-500m), *M. pseudimitans* (0-500m), *M. inequiunguis* (0-800), *M. hahneli* (1000-1600m).

To the date we have performed 228 successful experiments measuring the oxygen consumption of the adults of 21 species at four different temperatures, still a working effort of approximately 2 months of fieldwork is needed to get a representative sample size for the majority of the species.

We never got an answer from Idea Wild, the ONG to which we apply for the aquatic oximeter, so we have not begun to measure the larvae oxygen consumption. Instead we are running the following experiments with three species of Erythrodiplax (*E. abjecta, E. andagoya,* and *E. fusca*), in September 2018, we caught ovipositing females, we took the fertile eggs and began rising them at four different temperatures, one of them 3 ºC above the temperature experienced in the lowlands, one below the temperature experience in the highlands and the other two are the environmental temperature at lowlands and the environmental temperature at highlands, we are measuring the time between molts and the size the larvae grow under the same food regime, this will allow us to approximate to what will happen with the species on this genus under the predicted climate change scenarios.