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**Natural history of four species of *Platydracus* Thomson
(Coleoptera: Staphylinidae) in *Heliconia bourgaeana* Petersen
(Zingiberales: Heliconiaceae) flower bracts**

J. H. Frank

University of Florida, jhfrank@ufl.edu

M. A. Morón

Instituto de Ecología, A.C., Veracruz, MEXICO, Miguel.Moron@inecol.edu.mx

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Natural history of four species of *Platydracus* Thomson (Coleoptera: Staphylinidae) in *Heliconia bourgaeana* Petersen (Zingiberales: Heliconiaceae) flower bracts

J. H. Frank

Entomology and Nematology Department
University of Florida
Gainesville, FL 32611-0630, USA

M. A. Morón

Instituto de Ecología, A.C.
Carretera antigua a Coatepec 351
El Haya, Xalapa 91070, Veracruz, MEXICO

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J. H. Frank and M. A. Morón

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Natural history of four species of *Platydracus* Thomson (Coleoptera: Staphylinidae) in *Heliconia bourgaeana* Petersen (Zingiberales: Heliconiaceae) flower bracts

J. H. Frank

Entomology and Nematology Department
University of Florida
Gainesville, FL 32611-0630, USA
jhfrank@ufl.edu

M. A. Morón

Instituto de Ecología, A.C.
Carretera antigua a Coatepec 351
El Haya, Xalapa 91070, Veracruz, MEXICO
Miguel.Moron@inecol.edu.mx

Abstract. The insect fauna within inflorescences of *Heliconia bourgaeana* Petersen (Zingiberales: Heliconiaceae) was evaluated in Parque Metlac, Fortín de las Flores, Veracruz, Mexico between May and October 1995. Floral bracts were present in May and some persisted to October, despite much destruction in August by a grackle, *Quiscalus mexicanus* (JF Gmelin) (Icteridae). Flowers were abundant in the bracts in May-June, after which their number declined as fruits matured. Insects that fed on the flowers were most abundant in May-June; several of them could be pollinators; the immature stages of most of these insects were absent from *Heliconia* Linnaeus. The floral bracts contained water enriched by decomposition of the flowers, and this provided nutrition for aquatic organisms. Syrphid larvae (Diptera) contributed the largest biomass among the aquatic insects, and their distribution among bracts was more uniform in time than that of other aquatic insects. Larvae of Culicidae and Psychodidae (Diptera) were more variable in density and were more abundant after decomposition of the flowers. The most abundant aquatic predators of culicid larvae were larvae of *Toxorhynchites* Theobald (Culicidae). The most abundant amphibious predators of dipterous larvae were adults of four species of *Platydracus* Thomson (Staphylinidae), one of them yet undescribed. To capture its prey, the *Platydracus* adult would immerse its head and thorax, with open mandibles, to snap at passing dipterous larvae.

Key words. Veracruz, Mexico; phytotelmata; Culicidae; Syrphidae; predation

Resumen. La fauna insectil asociada con las inflorescencias de *Heliconia bourgaeana* Petersen (Zingiberales: Heliconiaceae) fue evaluada en el Parque Metlac, Fortín de las Flores, Ver., México entre mayo y octubre de 1995. Las brácteas florales estuvieron presentes en mayo y persistieron hasta octubre, aunque con mucha destrucción a partir de agosto debido a la acción del zanate mexicano (*Quiscalus mexicanus* (JF Gmelin), Icteridae). Las flores en las brácteas fueron abundantes en mayo y junio, después de lo cual su número se redujo conforme aumentó el tamaño de los frutos, los cuales maduraron en octubre. Los insectos adultos que se alimentaron en las flores fueron más abundantes en mayo y julio; varios de ellos podrían actuar como polinizadores. Los estados inmaduros de la mayoría de estos insectos no fueron encontrados en *Heliconia* Linnaeus. Las brácteas florales contuvieron agua enriquecida por la descomposición de las flores, lo cual proveyó de nutrimentos para algunos de los organismos acuáticos. Las larvas de la familia Syrphidae (Diptera) constituyeron la mayor biomasa de las larvas de insectos y su distribución fue notablemente uniforme entre las brácteas en cada espiga floral y a lo largo del periodo de observación. Las larvas de las familias Culicidae y Psychodidae (Diptera) fueron más variables en su densidad, y más abundantes después de la descomposición de las flores. Los depredadores acuáticos de las larvas de Culicidae más abundantes fueron larvas de *Toxorhynchites* Theobald (Culicidae). Los depredadores anfibios más abundantes de las larvas de dípteros fueron cuatro especies de *Platydracus* Thomson (Staphylinidae), una de ellas aun no descrita. Para capturar su presa, un estafilínido sumerge su cabeza y su tórax, con mandíbulas abiertas, en el agua e intenta capturar las larvas de dípteros.

Palabras clave: Veracruz, México; fitotélmatas; Culicidae; Syrphidae; depredación

Introduction

The microcosms in the water-filled flower bracts of some species of *Heliconia* L. (Zingiberales: Heliconiaceae) have been documented in several publications, including those by Seifert (1982) and

Machado-Allison et al. (1983), concentrating on the aquatic immature stages of terrestrial insects. Less well known is that some terrestrial insects of the family Staphylinidae (Coleoptera) may enter such bracts and prey on dipterous larvae and/or pupae. These staphylinids include adults of *Odontolinus fasciatus* Sharp (Seifert and Seifert 1976) and adults and, in some instances larvae, of some species of *Belonuchus* Nordmann (Frank and Barrera 2010).

In July 1992, while visiting southern Mexico on an unrelated project, one of us (JHF) encountered a natural population of *Heliconia bourgaeana* Petersen (Fig. 1) in Parque Metlac, close to the town of Fortín de las Flores in Veracruz state. A few glances into water-filled bracts revealed the presence of mosquito larvae, and he also saw an adult staphylinid beetle which was neither *Odontolinus* Sharp nor *Belonuchus*. The insect detected his presence, dived into the water, and hid among the bases of individual flowers where he could not see it. That behavior was curious because *Belonuchus* adults typically flee the bracts when they are disturbed in such a way.

In May 1995, JHF returned to Parque Metlac to investigate this strange staphylinid and its relationships with other inhabitants of the bracts of *H. bourgaeana*. The other author (MAM) obtained all necessary permissions to work in Parque Metlac and take the necessary biological samples.

Materials and methods

Parque Metlac consists of a riverine forest on the west bank of Río Metlac, largely natural, with addition of an unpaved road and some areas modified for human recreation (lawns, picnic areas, a swimming pool). It is available to the public by courtesy of its owner, Cervecería Moctezuma.

The plant, *H. bourgaeana*, is distributed in the riverine forest in groups determined by its reproduction, shaded by forest trees. It grows 1.2 to 5.5 m tall, there may be 6-17 red floral bracts when mature, and it may flower all year (Berry and Kress 1991). Its floral bracts are large. I assume that, as in other species with upright flowers (Seifert 1982, Machado-Allison et al. 1983) the water in the bract is replenished by rainfall, but also, in times of low rainfall, the plants pump groundwater into the bracts. As in other species with upright flowers, the flowers emerge from the water in the bracts and are continually surrounded by water until the bracts senesce and leak. The water in the bracts forms a moat around the sepals, perhaps preventing access to wingless terrestrial organisms such as worker ants. Each bract produces a line of flowers, which mature in sequence away from the rachis. Before the bracts begin to leak, the sepals, which are distally golden yellow, have senesced and fruits have appeared. The exocarp of the fruit is at first white, then blue, and it contains a very hard endocarp with 2-3 seeds. Insects hasten decomposition of the sepals, which may represent the largest input of nutrients into the aquatic microcosm formed by the bracts. Winged insects may be seen visiting the bracts, perhaps just to drink the bract water, or perhaps to seek nectar or pollen from the flowers. Other winged insects visit the bracts to oviposit because their larvae are aquatic. Yet other winged insects are seeking prey. All of the flower spikes (shoots) in the area were not counted at the first visit in 1995 (20 May), but JHF estimated >200.



Figure 1. *Heliconia bourgaeana* in Parque Metlac, Fortín de las Flores, Veracruz, Mexico, July 1992.

Growth of *H. bourgaeana* bracts

On 30 May, 12 flower spikes (A-L) were selected and all flower bracts were numbered from highest (an unopened bract) to lowest with a felt-tipped marker pen, in total A1 to L8. New bracts were expected to form above the marked bracts, and all could be recorded at the end of the study. The idea of marking all bracts with a conspicuous code, not just the topmost, was for convenience as well as to discourage their disturbance or removal by members of the public.

Weekly samples from bracts

At each weekly visit, beginning on 20 May, a shoot with 7 to 11 undamaged bracts was selected haphazardly (from a different patch of plants on each occasion). Bracts were numbered with felt-tipped pen, beginning with the topmost, then the rachis was cut beneath each bract in turn and the bracts were placed in polyethylene bags, which were sealed, placed in a cooled chest, and transferred to the laboratory for detailed examination of the contents. A more randomized collection, better for statistical purposes, could have been collected only by random selection of one bract from randomly selected shoots which would have resulted in unacceptable destruction of the >200 shoots in the study area. In the laboratory, the following day, each bract was dismembered in turn, and with much use of water from a wash bottle, all the insect inhabitants were removed alive for identification and enumeration of aquatic larvae and pupae for each bract.

Characterization of bracts

Bracts were characterized using the weekly sample of 8 bracts that was taken on 17 July. The volumetric content of each bract was measured by decanting all water in it and in the plastic bag that held it into a measuring cylinder. Each bract was then filled to capacity with tap water, and this water was then decanted into a measuring cylinder. All bracts contained flowers proximally and fruits distally, and they were counted in each bract as they were excised. Then the bract was filled with tap water, which again was measured in a measuring cylinder.

Samples from a second site

With the help of Celso Gutiérrez B. in specification of sites from which botanical samples of *H. bourgaeana* in the herbarium of Instituto de Ecología had been collected, on 11 May another site was visited in hope of replication. It was in the gorge of the Río Teocelo, ~2 km west of the town of Teocelo, SSW of Coatepec. It had <24 flower spikes (shoots) of *H. bourgaeana* inflorescences so was not ideal. On 18 May, one complete inflorescence was cut and the bracts were cut from it and placed individually into polyethylene bags as at Parque Metlac. The invertebrates taken from the bracts in the laboratory showed the same species composition as at Parque Metlac. When the site was next visited in June, almost all *Heliconia* inflorescences had been “harvested” by persons unknown. That site was not visited again. Other sites identified seemed very obscure or not natural, so were not visited. Thus there was no replication of sampling at Parque Metlac even though it was a 3-hr road trip journey from Xalapa. Volumetric capacity of the bracts was measured as ~ 100 ml by filling each of the seven collected on 18 May with water in the laboratory and pouring the water into a measuring cylinder.



Figure 2. *Culex bihaicola* female ovipositing in a bract of *H. bourgaeana*, Parque Metlac, July 1992.

Laboratory rearing and testing

Circular plastic containers 3 cm deep and 10 cm diameter, each with a colored opaque screw lid, were used as holding and experimental containers in the laboratory. When tap water was added, they allowed rearing of collected larvae of the aquatic insects. Food (*Heliconia* flowers) was provided for the syrphid larvae, *Culex* larvae were provided as prey for the *Toxorhynchites* larvae, but no food was provided for other larvae because (a) their food was unknown and (b) because it was believed that some of the larvae in final instar would pupate without feeding. For larvae that might need to emerge from the water to pupate (Psychodidae and Syrphidae), dishes were fitted with a paper coffee filter. Observation from above was not possible because of the opaque lid, but sometimes the beetles could be seen through the transparent walls.

Some of the adult staphylinids were placed individually into the containers fitted with coffee filters and containing aquatic dipterous larvae in water. They could of course escape from the water by retreating to the high ground provided by the coffee filter around the edge of the container but could not escape from the container. The objective was to determine whether the dipterous larvae could be captured and were suitable prey under very artificial conditions: it proved little or nothing about whether the staphylinids could obtain such prey in *Heliconia* bracts.

Photography of predation within bracts

In early October 1995, a transparent plastic “pet tank” (perhaps designed to house pet frogs or mice or even small fish) of about 2 liters was purchased at a department store in Xalapa. A median cut of a fresh *H. bourgaeana* bract was made vertically with a sharp blade, while avoiding cutting the flowers and fruits, and the section with the flowers was pressed up against an inner wall of the tank using slender sticks broken to the necessary length. The tank was filled with tap water to a height exposing the tops of unopened flowers. Mosquito and syrphid larvae were loaded into the “half bract”. Illumination within the “half bract” was obtained with fiber-optic lamps. Then, a staphylinid adult was loaded, and JHF prepared to wait and photograph events.

Pitfall trapping

In attempt to trap larvae of the Staphylinidae whose adults were seen in bracts, twelve plastic pitfall traps were installed on 9 August and left in position for 48 h. Each was about 1-liter capacity, was installed with its rim level with the soil surface, and two were placed among the plant bases of each of six clumps of *Heliconia*.

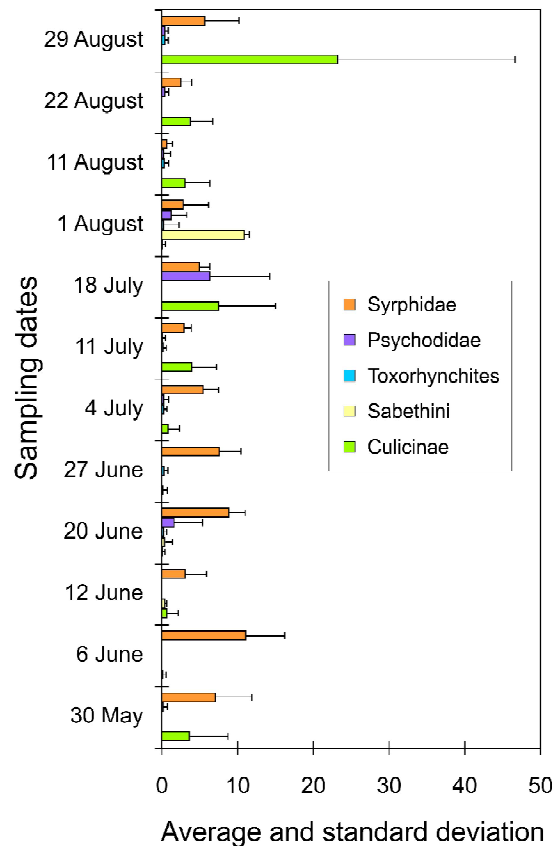


Figure 3. Histogram showing average numbers (with SD) of aquatic dipterous larvae per bract of *H. bourgaeana* in Parque Metlac from late May to the end of August 1995. All bracts of one entire inflorescence were cut on each sampling date and were taken to the laboratory where each was pulled apart and washed with water from a wash bottle to extract the inhabitants.

Insect visitors to flowers

Bracts taken from the field for sampling their aquatic fauna were also checked in the field for presence of terrestrial adult insects. Some of those insects observed were placed into vials for subsequent identification. No attempt was made to count all specimens of such insects, which would anyway have been an undercount, because some flew away when they were disturbed.

Results

Volumetric capacity of bracts

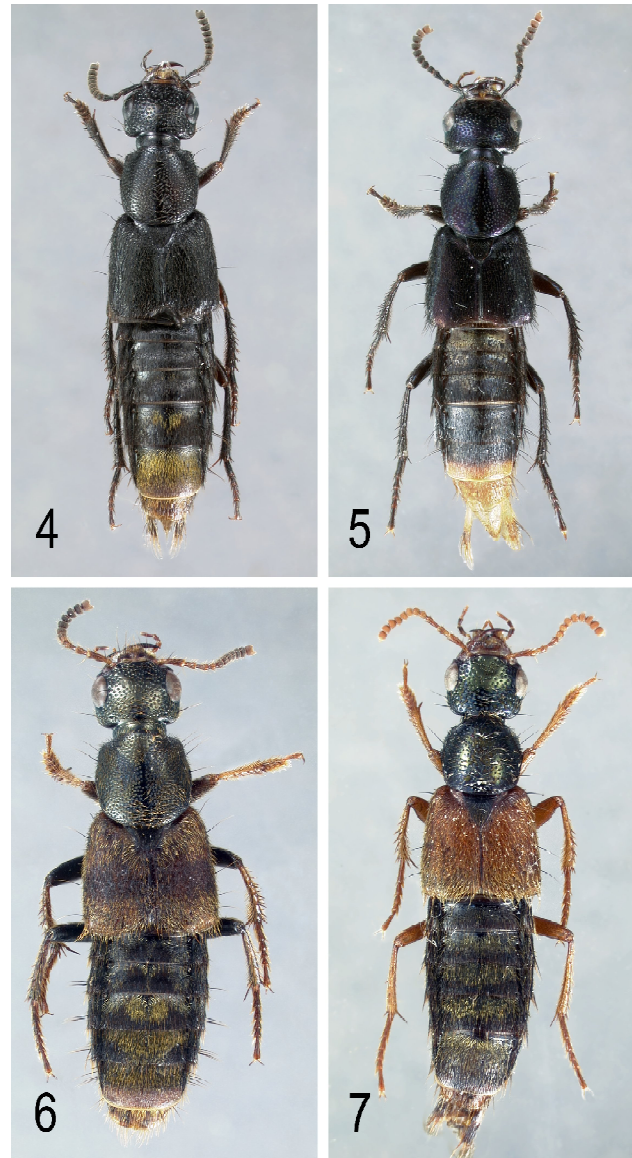
Average volumetric content of the 8 bracts (\pm SD) was 23 ± 9.1 ml. Average capacity of the bracts was 56 ± 12.6 ml. Average capacity of the bracts after removal of flowers and fruits was 73 ± 11.8 ml. Average number of flowers was 6 ± 1.2 , and average number of fruits was 14.0 ± 1.6 . The largest bract in that particular spike measured 86 ml without fruits and flowers, but the impression was gained that some inflorescences in the area had still larger bracts.

Identity of and notes on aquatic organisms

Coleoptera: Hydrophilidae: *Pelosoma* sp. The only two specimens were collected as adults, not larvae, but larvae may have been in very small numbers, thus not observed.

Diptera: Culicidae: Larvae of all species mentioned below were reared, and it was adults that were identified to species level using the keys in Lane (1953): (tribe Toxorhynchitini) *Toxorhynchites moctezuma* (Dyar and Knab), (tribe Sabethini) *Limatus durhamii* Theobald, (tribe Culicini) *Culex bihaicola* Dyar and Nuñez Tovar. They are listed apparently from the same location by Heinemann and Belkin (1977, collection record no. 442). Oviposition by *C. bihaicola* was observed (Fig. 2) in the field, as was that on 23 August at about 12:30 pm of *T. moctezuma*. Eggs of *T. moctezuma* and *L. durhamii* were collected from bracts but not enumerated. Larvae of *T. moctezuma* prey on other mosquito larvae, as is typical of *Toxorhynchites*; I verified that they feed on culicine and sabethine larvae and found that they would also feed on psychodid and syrphid larvae in artificial containers in the laboratory.

Diptera: Psychodidae: *Clogmia albipunctata* (Williston) (redescribed and illustrated by Ibañez Bernal 2008). Larvae were reared to the adult stage to obtain identification. Pupae were seen in the water in



Figures 4-7. 4) *Platydacus orizabae* (Bernhauer), male (9-11 mm, black, except for golden abdominal pubescence and lighter abdominal apex shared by the other species). 5) *Platydacus fauweli* (Sharp), male (10-12 mm, black, head, pronotum and elytra with metallic blue reflection, and with abruptly yellow abdominal apex). 6) *Platydacus gracilipes* (Sharp), male (11-14 mm, broader, black head and pronotum with metallic bronze or olive green reflection, with legs brown beyond femur, and elytra brown with prominent pale pubescence anteriorly and posteriorly). 7) *Platydacus* sp. 32, male (11-15 mm, head and pronotum with metallic olive-green reflection, with legs, antennae, and elytra red).

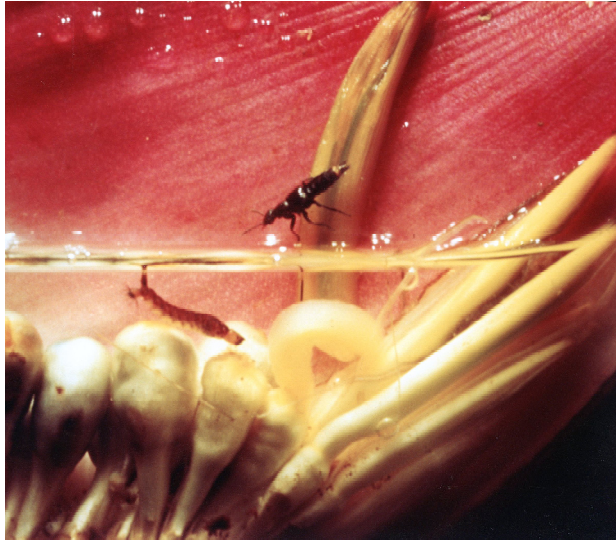


Figure 8. The interior of an *H. bourgaeana* bract showing (a) siphons of *Quichuana* larvae extending from between the flower bases to the water surface, (b) a large larva of the predatory mosquito *Toxorhynchites moctezuma* in the water, and (c) an adult of *Platydacus fauveli* perched above the water but apparently reacting to events in the water.

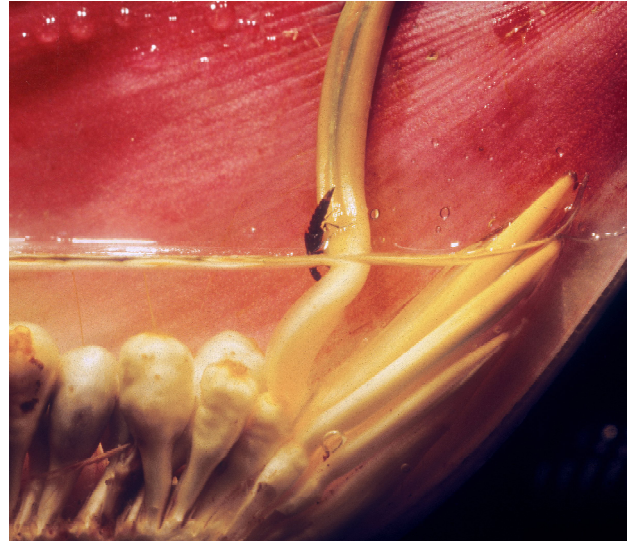


Figure 9. An adult *Platydacus orizabae* perched on an *H. bourgaeana* flower extends its entire head into the water; it seems that these beetles find the bract walls too slippery to provide a perch. This is an extraordinary behavior for a terrestrial beetle.

bracts, but in artificial containers they typically pupated above the waterline. A second species of psychodid was present and was about as numerous, but was not identified.

Diptera: Syrphidae: *Quichuana angustiventris* Macquart (all reference specimens except one, which was of *Quichuana subcostalis* (Walker)). They were observed as larvae and pupae and were reared to the adult stage to obtain identification. Eggs, believed to be those of *Q. angustiventris* were on one occasion observed on the exterior wall of a (topmost) yet-unopened bract; they were white and clustered; brought to the laboratory, *Quichuana* larvae hatched from them, so these hatchling larvae must migrate into the water in bracts. In the laboratory, these *Quichuana* larvae affirmed that they are amphibious by escaping from water-filled Petri dishes with loose-fitting lids were provided to the dishes. This suggests that they migrate in the field from bract to bract (see also comment below about *Dysdercus* nymphs feeding on a *Quichuana* larva). The larvae probably feed on the decomposing *Heliconia* flowers; they spend most of their time in the depths of the bracts among the floral bases, breathing through long siphons extending to the water surface, but they seem capable of migrating among bracts; in the laboratory, they pupated at or above the waterline in containers.

Diptera unidentified: a few larval specimens of some “higher” dipteran were collected, but were not identified.

Numbers of larvae of the aquatic Diptera sampled on each visit are graphed in Fig. 3.

Copepods were abundant in some of the bracts but were neither identified nor enumerated.

Identity of adult Staphylinidae visiting bracts as predators

Coleoptera: Staphylinidae: *Platydacus orizabae* (Bernhauer) 15 specimens, May-August and October (Fig. 4), *P. fauveli* (Sharp) 21 specimens May-July (Fig. 5), *P. gracilipes* (Sharp) 9 specimens, June-July and October (Fig. 6), *Platydacus* undescribed sp. #32 in the files of A.F. Newton, who is working toward a revision of all the species of this large genus in the Americas, 15 specimens, June-August (Fig. 7). A few additional specimens, placed alive into Petri dishes, managed to escape. One specimen of *Chroapterus* cf. *flagrans* (Erichson). The described species are listed without a species-level key in Navarrete-Heredia et al. (2002). No staphylinid larvae were found in *Heliconia* bracts nor were any taken in pitfall traps. The four *Platydacus* species form a predatory guild within the bracts.

Behavior of the four *Platydracus* spp.

(Fig. 8-10)

Immersion. Using adult *Platydracus* captured on 20 May, on the following day an adult of *P. sp. indet.* (#32) was placed into a glass jar fitted with a water-filled *Heliconia* bract cut down vertically (to about half its original height) to fit. It ran immediately to immerse itself in the water, apparently forming a plastron, seen as a silvery coating of air around the elytra. Perhaps it gripped the substrate to hold itself immersed. Identical behavior was displayed on the same day by a female *P. fauveli*. When circular plastic containers became available (31 May) and were fitted with coffee filters and filled with water, seven *P. fauveli* were placed into individual containers; one of these immediately (before the jar lid was replaced) immersed itself in the water and formed a plastron, probably gripping the rough surface of the paper. These observations, albeit under artificial conditions, confirm the original field observation in July 1992 that these beetles (or at least two of the four species) immerse themselves in water when alarmed.

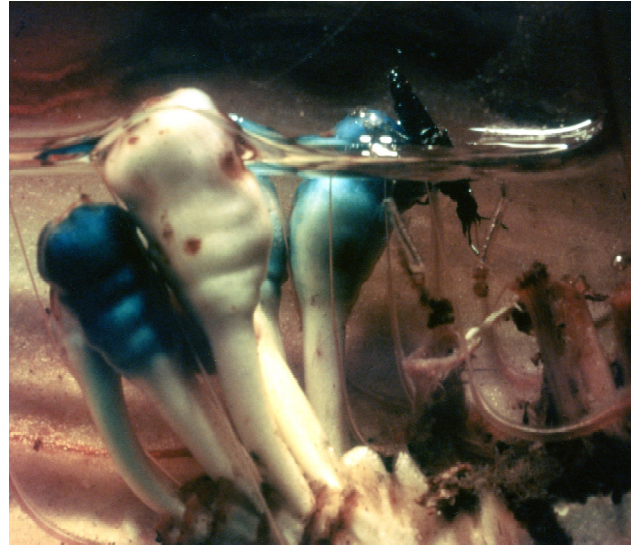


Figure 10. An adult *Platydracus* sp. 32 perched on an *H. bourgaeana* fruit extends its head and thorax into the water, opens its mandibles, and snaps at passing *Culex* larvae. This is a “fishing staphylinid” with behavior similar to that of a bear attempting to catch salmon at rapids on a Canadian river.

Predation in plastic containers fitted with coffee filters. On 1 June, four containers fitted with coffee filters were supplied each with five large syrphid larvae in about 1.5 mm of water. To each was added an adult *P. fauveli* captured the previous day. Containers were checked on 2, 5, and 7 June, noting the number and condition of the syrphid larvae. By 7 June, two of the beetles had killed and eaten all five syrphid larvae, and the other two had killed and eaten four. A repetition from 7 June until 21 June showed only one beetle had eaten all five syrphid larvae, one had eaten four, and two had each eaten two. None of the beetles was seen to enter the water to attack prey. Syrphid larvae were on some occasions found between the coffee filter and the container and were replaced in the water, demonstrating that they had migrated out of the water. This suggests that syrphid larvae are suitable prey and were likely captured as they migrated above the waterline. Consumption rate varied between one and five per week. Adults of each of the other three *Platydracus* species also were able to capture and eat syrphid larvae under similar but more sporadic conditions.

Similar trials were made with *Platydracus* no. 32 and *P. fauveli* against *Culex* larvae. When offered 10 instar IV *Culex* on 29 May, within minutes one of the former beetles was seen through the wall of the container, perched at the upper edge of the paper coffee filter consuming a *Culex* larva, and it managed to capture and eat 9 of the 10 larvae within 20 hrs. A second adult of the same species was offered 5 instar IV *Culex* on 23 August, and had eaten all of them by 28 August. A *P. fauveli* adult was offered instar IV *Culex* on 31 May, and had eaten 6 of them by 5 June (the remaining 4 had pupated). A *P. fauveli* adult was offered 10 instar IV *Culex* on 14 June and had eaten 7 of them by 21 June.

Fishing. On one occasion (7 October 1995) the tank with half a *Heliconia* bract was set up for observation by adding mosquito and syrphid larvae. An adult female *P. gracilipes* and adult *P. orizabae* were added. The *P. orizabae* was observed inserting its head into the water, opening its mandibles, and snapping at passing *Culex* larvae without success. An instar IV *T. moctezuma* was added and was grabbed immediately by the *P. orizabae*. The resultant struggles attracted the attention of the *P. gracilipes*, which grabbed the other end of the *T. moctezuma* larva which was then consumed by both beetles. On another occasion (17 October) with similar setup, a *P. orizabae* adult was observed almost continuously for 4 hr 40 min., during which time it was photographed fishing, frequently lunging at passing mosquito larvae

and missing from a perch on a *Heliconia* flower. On one occasion it missed its footing, fell into the water, and scrambled out. The setup was resumed the following evening for > 5 hr, and a *T. moctezuma* larva escaped capture by the beetle although it, itself, managed to capture and consume two *Culex* larvae.

Identity of adult insects visiting flowers

Hemiptera: Pyrrhocoridae: *Dysdercus* cf. *obscuratus* Distant. Four specimens of *D. obscuratus* were reported by Doesburg (1968) from “Rio Mellac near El Fortin [sic], 17.xii.1948, H.B. Leech” without plant association. A series of adults was obtained in May-July. On 10 August, eight small nymphs were observed feeding on a dead syrphid larva which was on the rachis below a bract. The syrphid larva was probably attacked while it was migrating from one bract to another, perhaps at night.

Coleoptera: Carabidae: *Platynus* Bonelli sp.

Coleoptera: Histeridae: *Hololepta* Paykull sp.; *Omalodes* Erichson (2 spp.).

Coleoptera: Scarabaeidae: *Ataenius chapini* Hinton (described as *A. frankorum* Deloya 2000, but synonymized by Stebnicka 2001), *Diploptaxis hirsuta* Vaurie 30.v.1995(1), 6.vi.1995(1), 20.vi.1995(1), 4.vii.1995(1), 11.vii.1995(1), 18.vi.1995(1), 1.viii.1995(1), 10.viii.1995(1), *Hoplia squamifera* Burmeister 20.vi.1995(1), *Onthophagus violetae* Zunino 20.v.1995(1), 6.vi.1995(1).

Coleoptera: Hybosoridae: two species of *Ceratocanthus* White, 13.vi.1995 (2).

Coleoptera: Lampyridae: *Bicellonycha* Motschulsky sp.

Coleoptera: Cantharidae: *Chauliognathus* Hentz sp., *Podabrus* Westwood sp.

Coleoptera: Chrysomelidae: *Diabrotica* Chevrolat (2 spp.), *Rhabdopterus* Lefevre (sp.), ?*Monolepta* Erichson sp., *Cephaloleia gratiosa* Baly (2 color forms of this “rolled leaf hispine”).

Coleoptera: Curculionidae: *Cholus nigrofasciatus* (Chevrolat), *Metamasius sellatus* Champion, *M. hemipterus* (L.).

Lepidoptera: Hesperidae: *Thracides phidon* (Cramer), only one adult specimen, apparently imbibing nectar.

Hymenoptera: Apidae: *Trigona fulviventris* Guérin-Méneville, *Apis mellifera* L.

No larvae of the Coleoptera, Lepidoptera and Hymenoptera were seen in the bracts.

Identity of birds visiting bracts

Occasionally, a hummingbird was in JHF’s field of vision. On one occasion a hummingbird hovered in front of him, but his camera was not in his hands and the opportunity for a photograph escaped him that hummingbird remains unidentified. In August, flocks of grackles invaded the area and visited the *Heliconia* bracts; JHF identified them as *Quiscalus mexicanus* (JF Gmelin) family Icteridae, called in Mexico zanate mexicano.



Figure 11. Bracts of *H. bourgaeana* destroyed by grackles (*Quiscalus mexicanus*) in August 1995 in Parque Metlac.

Growth and destruction of *H. bourgaeana* bracts

When they were first observed on 20 May, all bracts seen were in pristine condition. Of the 12 flower spikes whose bracts were numbered on 30 May, 10 survived intact to 1 August, and by that date those 10 had produced an average of 2.6 new bracts (range 1 to 7). The growth rate was little more than one new bract per month. In August, very many of the bracts of these observational plants were destroyed (Fig. 11). This destruction seems to have been caused mainly by *Quiscalus mexicanus*, a grackle. The birds seem to have ingested the fruits, digested the pericarp, and left the seeds (within the very hard endocarp) sprinkled on the ground close to the plants. It cannot be ruled out that they also ingested insects in the bracts, most likely the syrphid larvae which represented the largest biomass among all the insects present. By 22 August, 75% of the bracts had been destroyed by birds. In addition, a few bracts had been cut cleanly by knife or gardening clippers (secateurs), apparently by humans, despite the numbers that had been written on them by marking pen, which surely would negate their value as ornamental flowers. This unexpected destruction of bracts led to closing down routine field sampling, and trying to salvage what remained of the project by laboratory observations, instead of continuing the field observations for the planned 12 months (until May 1996).

Pollination

This focus of this study was not pollination, so numerical data on actual or potential pollinators of *H. bourgaeana* were not collected. Nevertheless, the bees *Trigona* and *Apis* were frequent visitors, nor can other insect visitors to the flowers readily be dismissed as pollinators. Hummingbirds were much less frequent visitors so far as JHF could tell.

Pitfall-trapping

The night of 9 August provided a lightning storm with torrential rain. No Staphylinidae, either adults or larvae, were collected in the traps on 10 or (after emptying of water from the traps) 11 August. The exercise was not repeated.

Conclusion and discussion

The habitat and role of the *Platydracus* spp.

Adult Staphylinidae belonging to the genera *Odontolinus* (Seifert and Seifert 1976) and *Belonuchus* (Frank and Barrera 2010) have previously been reported to attack mosquito larvae and/or pupae in *Heliconia* flower bracts in the Neotropics. This new report concerns adults of the genus *Platydracus* which likewise attack mosquito larvae and/or pupae in *Heliconia* bracts in the Neotropics.

Adults of one or more species in each of these genera, although they are “terrestrial” have now been shown to immerse themselves in water in *Heliconia* bracts, forming an apparent plastron on immersing themselves in the water of the bracts. However, it seems that *Odontolinus* and some *Belonuchus* adults immerse themselves in water to catch their dipterous larval prey. In contrast, *Platydracus* adults immerse themselves in water to evade their capture, and they capture their prey differently: either by “fishing” for it, or by capturing it when it migrates above the waterline.

Observations within sectioned *Heliconia* bracts in a tank showed that *P. orizabae* at least could capture *Toxorhynchites* larvae by “fishing”. Perhaps the reason is that *Toxorhynchites* larvae are incautious because they are the top aquatic predator within the little aquatic ecosystem. *Culex* larvae evaded capture by their vagility, and *Quichuana* larvae did so by their concealed position in the depths of the bract. However, *Culex* larvae are subject to capture in shallow water as must happen when bracts begin to leak as they age. *Quichuana* larvae may be immune to predation when they are concealed among flower bases, but are subject to predation by *Platydracus* adults in shallow water and, because these larvae are amphibious and move between bracts, they are especially subject to predation, even by nymphs of *Dysdercus*.

It should not be supposed that *Heliconia* bracts are the sole habitat of any of the *Platydracus* spp. mentioned. JHF was offered 2 specimens of *P. fauweli* and 2 of *P. gracilipes* collected by Alejandro Vázquez (Instituto de Ecología, Xalapa) collected in fallen decaying mango fruits in week beginning 18-VI-1995 at Apazapan near Jalcomulco. Mango is native to southern Asia, but is grown in Mexico and its fruits are ripe in June. These fruits provide a transient habitat and prey source (fly larvae) for just a few weeks in June. The flesh of the fruits is yellow, similarly to the flowers of *Heliconia*.

Dr. Al Newton kindly provided a file with his accumulated records for these four *Platydracus* species, which show their wider distribution as:

P. fauweli: GUATEMALA: Zacapa, MEXICO: Chiapas, Durango, Oaxaca, Veracruz.

P. gracilipes: MEXICO: Chiapas, Hidalgo, Oaxaca, Puebla, Tamaulipas, Veracruz,

P. sp. 32: BELIZE: Cayo, Toledo, GUATEMALA: Baja Verapaz, Chimaltenango, MEXICO: Veracruz.

P. orizabae: MEXICO: Chiapas, Durango, Veracruz.

Predation on mosquito and other dipterous larvae has now been demonstrated by various Staphylinidae (all of them in the subfamily Staphylininae) in *Heliconia* bracts. Observations of *Platydracus* doing so in *Heliconia* bracts reported here are novel. It appears that *Toxorhynchites* larvae, which are known as predators of other mosquito larvae in *Heliconia* bracts and other phytotelmata (Frank et al. 1984; Lounibos et al. 1987) may be prey of *Platydracus* as well as *Belonuchus*. Knowledge of such predation in other phytotelmata is still very limited. Predation on mosquito larvae in bamboo internodes by *Hesperus* (Staphylinidae: Staphylininae) in the Old World tropics was described by Schillhammer (2002). It remains an open question whether predatory staphylinids dwelling in bromeliad leaf axils prey on mosquito larvae (including *Toxorhynchites*): no such report was detected during preparation of a review of arthropods associated with bromeliads (Frank and Lounibos 2009), although there are scattered records of predatory Staphylinidae having been detected in bromeliads in Neotropical countries.

Comments on pollination

Pollination of *Heliconia* spp. by hummingbirds in Costa Rica was demonstrated by Feinsinger (1978). "All species of *Heliconia* I have seen are adapted for pollination exclusively by hummingbirds" (Stiles 1979). "In most cases [species of *Heliconia*] a pollinator is required to transfer pollen [which is done by] bird or bat pollinators; some insects [e.g., earwigs in Hawaii] are quite agile at transferring pollen within a *Heliconia* flower" (Berry and Kress 1991: 22). It seems strange that adult insects, belonging to groups known to pollinate flowers of other plants, were seen abundantly at the flowers of *H. bourgaeana* in the present study. If they were not receiving some reward (nectar or pollen or both) for their efforts, were their visits in vain? Only a count of pollen grains on hummingbirds and insects leaving the flowers, along with tabulation of frequency of visits, will begin to demonstrate the relative role in pollination by the two classes (insects and birds). Such a study was outside the scope of the reported project.

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Arizona) — *Cholus* and *Metamasius*; J.E. Lloyd (Entomology & Nematology Dept., University of Florida) Cantharidae and Lampyridae; M.S. Caterino (Santa Barbara Museum of Natural History, California) Histeridae; J.H. Epler, (Crawfordville, FL) — *Pelosoma*; A. Sourakov (Florida Museum of Natural History) — Hesperidae; R.W. Flowers (FAMU, Tallahassee, FL) Chrysomelidae except *Cephaloleia*; C.L. Staines (Smithsonian Institution, Washington DC) — *Cephaloleia*.

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Al Newton and Roberto Barrera kindly reviewed a manuscript draft. Michael C. Thomas (Florida State Collection of Arthropods) took Automontage images (Figs. 4-7), and Jane Medley (Entomology and Nematology Dept., University of Florida) enhanced many images.

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