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"The specific name *pnirsa* was given by Stal, 1860 (Ofv. Vet. Acad. Forh. Vol. 17, p. 462) to a unique specimen said to be from Costa Rica and this type has been figured by Jacoby, 1882 (Biol. Centr.-Amer. Coleopt VI, Pt. 1, p. 201, pl XI, fig. 18), to whom the species appeared to be an extreme form of *C. anchoralis*. This figure of Stal's holotype agrees so exactly with certain Canadian and Minnesotan specimens that I have little doubt that the Costa Rican record is an error and that the application of this name by Horn, 1884 (Can. Ent. Vol. 16, p. 128), accepted by Linell, 1896 (Journ. N. Y. Ent. Soc. Vol. 4, p. 199), is correct for this species. Its striking and unique appearance is due to enlargement and confluence of the small black elytral areas of our more familiar species, so that one sees only regularly placed white spots upon a black field."

The Canadian National Collection at Ottawa contains about twenty specimens of this rare beetle and through the courtesy of Dr. J. McDunnough I am able to close this paper with the locality records he has kindly furnished me, including in this list data from the collection of the late F. Knab of Washington, and, for the sake of completeness, my own locality record. The few recorded dates are all in June except those for four specimens from Montreal Island, collected Sept. 16, 1902.

QUEBEC: Montreal Island; Hull; Levis Co.; Chambly Co.; Rouville Co.

ONTARIO: Ottawa; Hamilton, and Western Ontario.

UNITED STATES: Rochester, Olmsted Co., Minnesota.

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## OBSERVATIONS ON THE ECOLOGY OF THE MAYFLY, *BLASTURUS CUPIDUS*.

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This mayfly, first described by Thomas Say in 1823, under the name of *Ephemera cupida*, with evident confusion of the sexes, was subsequently described by Francis Walker, Herman Hagen, Benjamin Walsh and Rev. A. E. Eaton. Walker added three synonyms and Hagen one more, though the latter corrected Say's error concerning the sexes. Walsh, writing from Rock Island, Illinois, in 1862, says that he found the subimago occurring rather abundantly "on rafts of Wisconsin pine-logs from the middle of May to the middle of June, unaccompanied," so far as he could discover, "by the imago." From these subimagoes he successfully reared one male imago. Rev. A. E. Eaton described and figured the legs and wings of the adult, and the nymph of an undetermined species of *Blasturus*, with its gills and mouthparts.

The nymph was first reared by Edward Berry in 1903. He figured the gills and tails. Prof. James G. Needham included this species in an account of the mayflies of New York State, with a new description of the nymph, which he had reared in 1897 from Six Mile Creek at Ithaca. Dr. Anna H. Morgan, (1911 and 1913) has given the most comprehensive account of this species. She figured the nymph, the male subimago, the imago, and the egg. The present paper is intended to supplement her work, and go more into detail as regards certain phases of the mayfly's life and activities.

## LOCAL HAUNTS OF THE NYMPH.

Many of the streams in the vicinity of Cornell University, Ithaca, New York, are favorable for the development of this interesting little mayfly, but most of the studies were made from Cascadilla Creek, in that portion of its course which is most convenient of access from the Campus. This creek is for a large part of its course rapid-flowing, over muddy or gravelly bottom, or over beds of shale. A careful study of this stream, its physical features, velocity and strength of current as well as chemical analyses of its waters, has been made by W. A. Clemens (1917), in connections with his study of the swift-water mayfly *Chirotonetes*. He has shown that the amount of pollution is not excessive, and that the oxygen content is high throughout the year. A low carbon dioxide content throughout the year is also shown, this being most noticeable in mid-summer. These results hold good both for the swift-water, haunts of *Chirotonetes*, and the quieter backwaters more favorable for the development of *Blasturus cupidus*.

A favorite haunt of the *Blasturus* nymphs during the autumn months was a portion of Dwyer's Pond that lies beneath a spreading hemlock in an area of relatively quiet water, which had however, at all times a distinct though sluggish current flowing through it. A jutting shelf of rock cuts off the main stream, and in the shelter thus formed a swampy growth of burreeds extends down into the pool beneath the hemlock. A bed of brownish mud and ooze is thickly overgrown with *Elodea* and fringed with the burreeds, and here the nymphs are very abundant. The water here, though shallow, did not freeze over until the weather became quite cold, there being small springs flowing into it. Shelter also was afforded by the big tree. At any rate, *Blasturus* could often be taken here without trouble, when the adjacent swift water was covered with an inch or more of ice.

During a January thaw, *Blasturus* nymphs were collected from grasses and roots close along the shore of the swifter portions of the stream some distance above Dwyer's Pond, where the depth of the creek was from 6 to 15 inches. Clinging here near the banks, they were not washed away nor frozen into the ice, and seemed to thrive as well as in the quiet backwaters. Nymphs taken from this environment were placed in quiet water in the Laboratory, and with a few exceptions were reared to subimagoes and adults.

Later in the spring many nymphs were taken from a small pool near the main stream of Cascadilla, which seemed to have, however, no connection with the main stream. The nymphs must have spent their entire life cycle in this absolutely quiet water.

## THE NYMPH

The nymphs of *Blasturus* are graceful, brownish, insects, somewhat flattened in shape of body, with large, conspicuous, plate-like gills. The upper part of the body and the legs are marked and blotched with a darker color, this being most noticeable in a nymph that has just molted. The gills are often most beautiful, seeming to have the texture of delicate silk. They give the nymph a flounced effect. They are rather easily broken off, and it is not unusual to see a nymph, especially in the stage just preceding its emergence, with but one or two pairs of gills remaining. Sometimes all those on one side are lost. In the earlier periods of its career, such lost gills are without doubt regenerated, as small nymphs minus a pair of gills when collected, cannot be distinguished from the others in

two or three weeks time.

The legs are fitted for walking or climbing, and the nymphs are quite agile in such movements. The tails are moved up and down at frequent intervals, both when feeding and when at rest. These are long and are fringed with many short bristles. They seem to be useful in aiding the nymph to balance itself when swimming. Nymphs which had in some way lost all but the mere stubs of the tails often seemed much averse to swimming, or if they did make the attempt, moved only for short distances, sometimes falling on their backs and only righting themselves with difficulty. Their method of swimming then was very jerky, much different from the ordinary movement of the nymphs through the water.

Blasturus nymphs seem to depend for protection more upon coloration than upon swiftness of movement. When resting quietly upon a spray of Elodea or a bit of burreed stem, they are almost invisible, even in the laboratory under unnatural conditions. The movements of the nymphs are slow as compared with those of many other mayflies. They can move both forward and backward with equal facility, and will often sidestep quickly if disturbed from above. Although rather slow, they often move quite a distance without stopping. Six nymphs were selected for an experiment to show the actual distances travelled at one time. The average distance travelled by these nymphs in one effort was 137.0 mm., or more than 10 times the length of the largest nymph.

In swimming, the nymphs progress rather slowly through the water by means of a series of wave-like undulations of the body. The abdomen, tails and gills serve as organs of propulsion, while the fore part of the body moves up and down alternately with the movements of the abdomen. The legs are held more or less stiffly while swimming, and the abdomen does most of the work of pushing the body forward.

Nymphs of Blasturus will often feign death when disturbed especially if removed from the water. They remain very quiet, whether on rubbish or lying unprotected by their natural back-ground. After a time, however, they quickly recover themselves and run about briskly. The length of time during which a nymph will thus feign lifelessness varies with conditions and with individuals. One nymph remained thus for 13 seconds when first disturbed, but only for 8 seconds when disturbed immediately afterwards. Many remain in this attitude for a much longer time. Nymphs which had been kept for some time in the laboratory and handled almost daily, seemed to feign death only for a very brief time.

The nymphs seem very social, being usually found together in some numbers. When observed in the laboratory, they live together very peaceably. Two or three will often stand facing each other quietly for several minutes, occasionally greeting one another by touching their antennae together, tip to tip. When several are feeding on the same burreed stem, one will often lash out sidewise with its tails, as though to frighten away the other nymphs. If two come along the stem directly toward each other, some such performance as this may take place: one endeavors with quick movements of the head and jaws to intimidate the other. This proving ineffective, it approaches nearer, rears its forelegs and the fore part of its body toward the other, threateningly. This threatening attitude is often assumed by the two nymphs alternately. After a few seconds of this peculiar demonstration, in which neither yields ground to the other, both nymphs fall to

feeding again, near each other, quite amicably. If, however, one nymph has the superior position on top of the burreed, another, approaching from below seems to find the vantage point of his opponent too strong a factor against him, and soon moves away, after a little display of rearing on the part of the favored one.

The mouthparts of *Blasturus* nymphs are rather generalized. Brushes of hairs upon nearly all of the mouthparts are probably useful as diatom rakes, particularly those of the maxilla, many of which are barbed and bent slightly toward the front. In the case of one medium-sized nymph which was observed feeding upon a spray of cladophora, the action of the maxillary and labial palpi could be plainly observed sweeping the food toward the mouth. The action here seemed to be mainly one of scraping diatoms from burreed stems or from sprays of *Cladophora*. Some sprays of the latter, examined under the microscope, were seen to be well coated with the diatom, *Cocconeis*. These were given the nymphs, which fell to stripping them eagerly. The same sprays were later re-examined and it was found that the nymphs had done the stripping work with considerable thoroughness. Burreed stems seemed on the whole acceptable, and were also easy of access, so these were used to furnish the bulk of the food for the nymphs in captivity. The smaller nymphs confined themselves mainly to stripping these stems of their thick coating of diatoms, while the larger ones fed also upon the actual tissues of the burreed, skeletonizing them in a short time.

In the winter and spring of 1919, nymphs captured at various times and in various places were examined for their stomach contents, and the results of 57 such examinations are here tabulated.

RECORD OF EXAMINATIONS OF STOMACH CONTENTS OF BLASTURUS NYMPHS.

Dates when taken	Ja. 17	Ja. 25	Fe. 7	Mc. 4	Ap. 7	Ap. 24	My. 1	My. 3	My. 5	Total
Number examined	8	5	8	2	5	9	10	5	5	57
Diatoma	6	4	8	1	5	1	2	1		28
Navicula	7	5	8	2	3	8	10	5	3	51
Synedra	3	3	8	1	2	5	3	2	2	27
Meridion	3	1	8	2	2	5	1	4	2	28
Cymbella	4	3	8	2	4	7	5	4	1	38
Cocconeis	1				4		2			7
Stauroneis	1	2				2			1	6
Gomphonema	2				1	1	5	1		10
Other diatoms					1	1	8	3	2	15
Cosmarium							1			1
Zygnema							5			5
Cladophora	1		2	1	3	1	7	2	1	18
Ulothrix	5	3	4		3	3	10		1	29
Tribonema							3			3
Unidentified Algae	4	2	1				11	2	1	21
Seed-plant tissues	7	5	8	2		3	7	5	4	41

It will be noted that the food varies with the season, and that those diatoms which are common throughout the year appear most frequently in the diet. Tissue from higher plants is found quite commonly, as likewise are algae of various kinds. While the nymphs may have certain preferences in the matter of food, in the main they accept whatever soft vegetable substances a given season

and a given locality present.

That the nymphs may likewise take animal food, is evident from this observation. A small nymph was one day seen clambering about on the back of a large one, and removing diatoms from him. A vorticella had lodged on the thorax of the large nymph, and this little creature was, after three unsuccessful attempts, captured and eaten.

The process of moulting is in some respects akin to the final transformation from aquatic to aerial life, in respect to the actions of the nymph at both these periods. A nymph will lie flat on the bottom of an aquarium, move its abdomen in an undulating fashion, beginning at the tip and working forward, till presently the form of the nymph is seen within the outer skin. This skin splits and the nymph is free. It may take two minutes to accomplish the moult, and a few seconds more before the nymph begins its usual activities. The nymph is usually quiescent also for a short time preceding the moult. In early spring the nymphs grow very rapidly, the difference in size after each moult being very apparent.

The period just preceding transformation is full of danger for all mayfly nymphs. As they migrate toward the shallow waters near the shore many predaceous creatures follow them, and the nymphs fall easy victims to these marauders. Examinations of black-nosed dace (*Rhinichthys atronasus*) prove that a large percent of the food of these fishes consists of mayflies, and *Blasturus cupidus* was more than once found to be present. The stonefly *Perlinella drymo* was seen several times in the act of killing and devouring a *Blasturus* nymph, and a considerable number of these stoneflies were found in the shallow pool. None of the various sorts of predaceous beetles were ever seen to attack a nymph.

#### THE SUBIMAGO

As the time for this transformation draws near, a change in the actions and appearance of the nymphs may be observed. Males soon show reddish eyes, which upon examination are seen to be dividing into the upper and lower eyes of the adult insect. The wing pads of both sexes are gradually elongated, and very shortly before the transformation, a crumpling of the wings within the pads can be seen. Nymphs which have been living at some distance from the shore now begin to come in toward the shallow water, often entering temporary pools, which may dry up before they are fully developed. In these pools the nymphs swim about restlessly, especially during the warmer hours of the day, for several days before they are ready to transform. Here also come many enemies, and the death toll among the nymphs in such a shallow pool may be very great.

The time of this migration seems to vary considerably with local conditions. The spring of 1918 was quite warm and well advanced by the first of May, and nymphs were observed emerging on May 2. In somewhat more than a week the height of the transformation seemed to have been reached. In the late season of 1919, however, the height of transformation seemed to be about May 20th.

Nymphs which had been collected during a thaw in January and February, grew rapidly in the aquaria at the laboratory, and transformed a few at a time during the latter part of February and during March. The first one emerged on February 17. These adults would not mate in captivity and usually

lived less than 24 hours after the final moult. They were smaller than those taken later in the spring, which had lived wholly under natural conditions.

A female nymph which emerged on February 17 was observed carefully during her transformation. The nymph seemed to be acting strangely. First lying on its back, then swimming to a burred stem and clutching it with its feet. Soon convulsive movements of the abdomen and tails occurred, beginning near the tip and working forward segment by segment. Next the thoracic region jerked, seeming to rise and fall. Whitish threads appeared along the upper center of the thorax, then a split over the meso- and metathorax, through which the head and prothorax of the subimago were thrust, shortly followed by the wings. The subimago rested a few seconds, then vibrated its wings and stepped clear of the nymphal skin. A large drop of liquid substance was expelled from the abdomen. The whole procedure required 6 minutes.

Several records were kept of the length of time required for the nymphs to effect this transformation, one nymph which was quiescent for 105 minutes had also a long period of activity immediately preceding transformation, for it swam about for 18 minutes, and required but 2 minutes for emergence, a total of 125 minutes. A second nymph required 116 minutes, a third but 42 minutes. The length of time required seems to vary considerably with different nymphs.

The subimago, as it steps free from the nymphal skin, is a dull brownish gray in color, but approximately the same size as the adult insect. The eyes of the male are large, taking up most of the space on the head, while the female's eyes are small in comparison. The tails are not as long as in the adult, but the middle one is proportionately longer. Neither the body nor the wings show any particularly striking markings. The mouthparts are useless, as in the adult—an amazing change from the efficient jaws of the nymph. This is the time for resting quietly and for the maturing of the sex organs.

The subimago remains for a short time resting upon the nymphal skin or upon some nearby support, and is then ready to fly. The length of time which may elapse between its transformation and its first flight varies with the atmospheric conditions. On a bright sunshiny day the creature may rise from the water after a few seconds of rest, and fly directly upward toward some tree on the bank. If the day be cloudy, however, it often rests for several minutes on or near the surface of the water, then makes a short flight to grasses or weeds overhanging the bank.

Birds are ever ready to snatch a subimago as it flies by. At the surface of the water are other foes, ready to pounce upon it at its most helpless moments; water-striders and other predaceous Hemiptera.

The length of the subimago stage was timed in a number of cases with the following results:

Time	18	19	20	21	22	23	24	25	26 hrs.
Number females	2	1	0	3	5	8	4	0	1
Number males	1	0	2	0	5	9	8	2	0

The average number of hours for the females was 22.4, for the males somewhat higher, 23.01 hours. The average time, for both males and females for the fifty specimens here recorded, was 22 hours and 42 minutes.

## THE FINAL MOULTING.

The subimago remains more or less quiet for nearly 24 hours, as just shown, and is then ready for the last moult. This moult again resembles in many respects the normal moulting of a growing nymph and the transformation of the nymph to the subimago. In this case, however, the wings must also be pulled out from the tissue enclosing them, and any slightest injury to these delicate organs before the time for this last change usually causes disaster.

A subimago would take a firm grip on some convenient object, wave its wings up and down a few times, then gradually lower them till they were at right angles to the body and their tips were as low as the body. The characteristic wave-like contortions of the abdomen were observed at this moult also, beginning as always at the caudal and working forward. The wings were moved backward little by little, gradually decreasing the angle between the wings and the body, till they were held flat against the abdomen. The thorax then split along the median dorsal line, the head and thorax of the adult at once pushed through the opening, followed immediately by the upper portion of the wings and the abdomen and the legs. The legs were held seemingly rigid for several seconds after the adult had emerged. Then the adult grasped the support with its feet, and pulled out the tails and the tip of the abdomen from the subimaginal skin. The whole proceeding occupied 6 or 7 minutes. The adult is at once very active and immediately flies away.

## THE IMAGO.

The wings of the imago are burnished and scintillate in the sunlight. In the distal costal space of the fore wings of the male is a spot, which seems to have no counterpart in the wing of the female. The two outer tails, particularly of the male, are longer than in the subimago, the middle one appearing quite short by contrast. The fore legs are usually held straight out before the body, as though serving to counterbalance the very long tails. Whether at rest or in flight they are always held stiffly ahead of the body. The flight of the adult is somewhat more rapid than that of the subimago.

While many flights or swarms containing only males were observed, no real mating flights were seen during the course of these observations, though many afternoons on apparently favorable days were spent in the field. The "stag" flights usually began about 3 p.m. and lasted intermittently till nearly 7 p.m. At no time were more than a dozen insects seen flying at once, and none of these swarms were directly over the water. One favorite location for this dance was a small grassy plateau about six feet from the water's edge, upon which the last lingering rays of sunlight fell. Here, in the sun's departing beams, the dance went on and on. Often the insects were rising not more than 7 or 8 feet and then with the undulating downward sweep, coming within a few inches of the grass. The wings glistened brightly in the light and were a better guide to the location of the imago than the tails, which could barely be seen a few feet away. The downward movement is apparently a mere falling with the force of gravity, the tails and fore legs serving to increase resistance. Then the insect slowly but surely rises again, to repeat the performance. There is a rhythmic swing to the dance, though each dancer keeps his own time.

None of the imagoes kept in captivity, at ordinary room temperature,

lived more than 24 hours, and some less than that time. None of these had mated. Miss Morgan (1911) estimates that the number of eggs laid by one female is thirty-seven hundred.

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FOUR NEW PHLOEOTHIRIPIDAE FROM THE UNITED STATES  
(THYSANOPTERA).

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The types of the new species described below are in the author's collection.

**Rhynchothrips debilis** sp. nov.

*Male* (macropterous). Length about 1.3 mm. Color light brown, with orange red subhypodermal pigmentation; antennae pale yellow, gradually shading to light brown in segments 7 and 8; legs light brown, with tarsi, distal ends of tibiae, and inner surface of femora (except at extreme base), pale yellow; fore wing heavily clouded with brown, much darker basally; hind wings brownish at extreme base, clear beyond.

Head broad, nearly 1.25 times as wide as long, broadest behind eyes; cheeks rounded, distinctly converging posteriorly, the head at base 0.85 the greatest width; lateral and dorsal surfaces striate with widely spaced anastomosing lines, which become reticulate on vertex, and with the usual minute, transparent bristles; vertex broadly rounded in front, overhanging insertion of antennae and bearing the anterior ocellus at its extremity; postocular bristles nearly as long as eyes, almost pointed, dark in color; a pair of strong bristles on the same line with, and dividing into thirds the space between, postoculars. Eyes about one-third as long as head, nearly as wide as their interval. Ocelli situated well forward. Antennae nearly 2.8 times as long as head; segments 3-8 long and slender, 4 much longer than 5 and about 2.4 times as long as wide; 3-5 subclavate, pedicels not sharply separated from rest of segment; 6 and 7 distinctly pedicellate, the latter broadly united to 8, which is slender and nearly three times as long as wide. Mouth cone long and pointed, reaching middle of mesosternum.

Prothorax along median dorsal line only 0.57 as long as head and (inclusive