BIONOMICS OF CATORHINTHA MENDICA STAL (COREIDAE, HEMIPTERA).

By W. V. Balduf, Urbana, Illinois.*

This large common native American coreid bug, described 72 years ago from Texas and Mexico by Stål (1870), has received only scant and incidental attention from investigators to date. Blatchley (1926) assembled most of the published references and stated his personal observations on its occurrence and food plants in Indiana. My study of its bionomics was made largely in the general vicinity of Urbana, Illinois during the years 1940 to 1942. Being monophagous on a plant whose physiological states vary sharply by seasons, this bug illustrates in an unusual degree the influence food plants may exert on insect development. For descriptions of the several stages, see the next article, by James S. Slater, in this Bulletin.

Food Plants.

Although Hart reported *Catorhintha mendica* "common on *Rhus aromatica, Allionia nyctaginea* and a variety of other plants" in the sand areas of western Illinois, he did not necessarily intend to state that it fed on any or all of them. Blatchley definitely associated the bug with *A. nyctaginea,*—the heart-leaved umbrella-wort or wild four-o'clock, as the "host plant." In all my observations in Illinois and at several points in northern Indiana and Ohio, I found it only on this wild four-o'clock. Neither nymphs nor adults were taken in sweeping non-nyctagineaceous plants growing among or adjacent to *Catorhintha*-inhabited *nyctaginea,* and not only the nymphs and adults were frequently seen in numbers only on the leaves and flowers of this plant but also many eggs were found laid on it. The occasional occurrence of a nymph or adult on other plants than *nyctaginea* does not invalidate the conclusion that the species is monophagous on *nyctaginea* in the area investigated. It is possible that *mendica* will eventually attack our ornamental four-o'clock, or Marvel of Peru, *Mirabilis Jalapa.*

The technical names mostly applied to the wild plant to date are *Allionia nyctaginea* Michx. and *Oxybaphus nyctagineus* (Michx.). In a recent critical study of the *Allionia* complex of the Americas,

* Contribution No. 232 from the entomological laboratories of the University of Illinois. I am indebted to my botanical colleagues, Doctors L. R. Tehon, H. J. Fuller and G. N. Jones for technical information concerning the food plant of *Catorhintha.*

Standley (1931) discovered intergrading forms from which he concluded that the generic concepts formerly held are no longer tenable. Accordingly he reduced them to a single genus under the name *Mirabilis*. The name of the food plant of this *Catorhintha* therefore becomes *Mirabilis nyctaginea* (Michx.).

Feeding and Shelter.

The large nymphs and the adults rest and feed largely on the succulent upper leaves and on the flower parts, which are terminal. There they are readily and commonly seen. But on hot sunny days they descend to the shaded leaves and stems, or even sit on the intermingled non-nyctaginaceous plants. Again, when *Mirabilis* is in flower or seed, the nymphs of the first and second instars hide, and probably also feed, entirely from external view within the involucral bracts that enclose the flower clusters or seeds. The more advanced nymphs are too large to take refuge thus. For example, on the hot bright afternoon of June 15, 1942, I at first gained the impression that no nymphs had developed, but on opening the involucres found them numerous within, as many as six individuals of the first and second instars hiding in a single circle of bracts. Since this situation affords both food and shelter, it is likely that the small nymphs live there most of the time that involucres occur. This likelihood is rendered all the more plausible by the fact that the two seasons in which small nymphs occur in large numbers—namely May–June and August–September, are simultaneous with the prevalence of involucres. The practice of hiding thus has a practical bearing in the work of taking samples, for it is probable one does not secure by sweeping, a proportionate number of the smaller bugs during the long periods when the plant bears involucres.

Distribution.

Inasmuch as the distribution of both *mendica* and *nyctaginea* are still being investigated, it will suffice here to note that both these organisms seem to have originated in southwestern United States or northern Mexico, and have subsequently spread northward and eastward into Iowa, Nebraska, South Dakota, southern Minnesota, Illinois, Indiana, Ohio and doubtlessly other states adjacent to these. Both plant and bug seem still to be actively spreading eastward, the insect following in the wake of its food plant, which has appeared in Connecticut, whereas *mendica* has not yet been reported east of Ohio. In east central Illinois, I have found both organisms plentiful, yet still confined almost entirely to the well-drained parts of railroad

embankments. This fact suggests that *nyctaginea* was disseminated by trains carrying the seeds in grain or live stock cars, and that *mendica* trailed along some time later after the plant had established itself in new frontiers. However, in areas long occupied, both plant and bug have, in all probability, moved from the railroad banks into such suitable situations as lie adjacent to them.

Dependence of *mendica* on *nyctaginea*.

Because *C. mendica* seems to be monophagous in the Urbana area, its seasonal populations, if not also the number of generations per year, are directly and drastically affected by the growth and reproductive habits of its food plant, *M. nyctaginea*. This marked dependence was strikingly apparent in each of the three years in which this investigation proceeded, and is probably a regular annual occurrence, but with variations in intensity from year to year. The statement which follows is based on data taken in 1941, unless otherwise noted, when weekly samples of the bug and notes on the developmental state of the food plant were taken from May to November.

Mirabilis nyctaginea formed new shoots from wintered taproots about the middle of April. In 1942, the first new growth appeared in the week of April 12–19. The new plants became full grown by June 1, but flower buds developed earlier, followed by deep pink flowers, some of which persisted past the middle of June. By mid-July, most of the seeds had been produced and dropped in east central Illinois. Then in late June and early July, simultaneous with the maturity of the large yield of sizable, hairy, ribbed seeds, the stems and branches became woody and lost their sap, and, particularly in the somewhat drier summer of 1941, dropped most of their leaves. When the food plant had reached this state, *C. mendica* had attained a large nymphal population, that originated from the eggs deposited by overwintered adults. Still requiring much food to complete their development, the nymphs supposedly were able to obtain no more sap, or an insufficient quantity or quality of it from the plant, with the direct and prompt result that large numbers of them died of starvation.

The factual basis for this general deduction is found in the data from field samples. The weekly collections taken from June 5 to 28, when *mendica* was still flourishing on the still more or less succulent food plant, totalled 433, 658, 372 and 490 individuals, respectively, or an average of 488, whereas the sample of July 4, when *nyctaginea* was most desiccated and defoliated, consisted of

only 77 bugs, or approximately 16 per cent of the average for June.

Similar dependence of *mendica* on *nyctaginea* was observed also during the rest of the summer and in the fall. Having completed its seed production, *nyctaginea* made a complete vegetative recovery from July 11–26, involving the growth of many new leafy branches from the upper axils and numerous clusters of flower buds and involucres. This verdant, succulent, nutritious condition persisted into October, probably because most of the buds never developed into flowers or seeds. Following this recovery at a distance of several weeks, *mendica* restored its population to its former mid-June level. Whereas the samples of July 11 to August 9 contained 50, 22, 58, 14 and 6 bugs, respectively,—mostly adults, or an average of 30 individuals, those taken from September 19 to October 25 numbered 101, 451, 219, 318, 326, 472 and 219, respectively, or an average of 301, or an increase of 900 per cent over the population of midsummer. These peak numbers of autumn themselves suffered a decline from latter October to early November. Two causes operated to effect this result. First, as adults developed and stored reserves in their adipose tissue, they left the food plant, and second, a considerable number of nymphs starved, for *nyctaginea* had again turned woody, dry and leafless on October 25. Whereas 219 bugs were taken on the latter date, only 34 formed the sample of November 3, and none remained available by sweeping *nyctaginea* on November 14.

It therefore seems conclusively demonstrated that the population of *mendica* fluctuates with the seasonal reproductive and vegetative processes of its food plant. These numerical fluctuations are so prompt and extreme because the bug places its entire dependence on *nyctaginea* and because the latter itself is characterized by sharp elevations and slumps in contents of sap, which forms this insect's food.

Enemies.

Although eggs, nymphs and adults from the field were caged, numerous nymphs examined with a binocular microscope and hundreds of adult females dissected, no conclusive evidence of parasitism was found in the course of this investigation. However, the abdomen of an occasional adult bug bore externally an elongate-oval, cream-colored convex body about a millimeter long, which was perhaps the egg of a parasitic dipterous fly. Although the attached ventral wall of these bodies and also the cuticula directly beneath it had been perforated, suggesting a larva had hatched and

entered the body cavity of the bug, no such larva was ever found by dissection. Moreover, no predatory enemies of any kind were found.

Mating.

Although the adult bugs are numerous and readily seen on the food plant, I have noticed the mating posture but once. This fact suggests that the copulatory act is brief and the bugs quickly disjoin when disturbed. In the one case observed in northern Ohio, on June 7, 1941, the paired couple rested on the upper surface of a leaf of *Mirabilis,* the caudal ends united and the bodies in linear position, *i.e.,* the heads extended in opposite directions.

Oögenesis and Oviposition.

The submature oöcytes are elongate-oval but when they reach the base of the ovarioles have become elongate six-sided. Soon after passing to the paired oviducts they change from white to dark dull brown. The paired ducts as a whole serve for storage of the mature eggs, being fitted for this function by their extreme length, flat form, great flexibility and transverse corrugations. These features give the ducts a superficial resemblance to tapeworms. All numbers of eggs up to 20 may occur in each duct, but the higher numbers cause the ducts to stretch and, moreover, to become extremely kinked. The latter condition is, I believe, due to the restraining pull exerted on the ducts by the tracheal branches that permeate their walls. The short median oviduct bears dorsally a complexly constructed spermatheca, and laterally near the apex a dark reddish spongy bluntly-ramose organ, which is presumably the cement gland.

Of a collection of 156 eggs removed from *Mirabilis* afield on June 1, 1942, all but two had been stuck fast to the outer faces of the bracts that form the numerous involucres then present at the termini of the branches. The other two were on a tender leaflet about 4 inches below an involucre. The eggs are therefore laid on the parts from which the females, and other forms of *mendica* obtain their liquid food. The 156 eggs appeared in lots composed of one to six eggs each, as follows: two lots of one egg each, 26 of two each, 25 of three, four of four, one of five and one lot of six eggs. Masses containing three or more eggs have them arranged in two to four flat horizontal tiers, the number of eggs forming them decreasing from bottom to top. Further, the eggs of each tier usually lie with their lateral faces in full contact or juxtaposed, and the cephalic or caudal ends of all are directed in one way and flush with each other.

Where two eggs form a mass, they may lie with lateral faces juxtaposed, or one superior and flat on the other. If the substratum is uneven in any way, the arrangement of the eggs in the mass is correspondingly irregular.

Incubation and Hatching.

Eggs laid on a caged *Mirabilis* required seven days for embryogenesis, and the last of the 156 eggs referred to above likewise hatched in six to seven days. Upon emerging, the embryos either push the oblique terminal subquadrate operculum free from the rest of the chorion or leave it attached by more or less of its margin to the edge of the aperture. In either case it rolls up somewhat at the edges, indicating it is thin and flexible in structure. Some embryonic membranes remained partly inserted in the aperture, while others lay near it, showing the embryo molts to the nymphal form as, or soon after, it issues from the chorion.

The Wintering Stage and Habitat.

I have two kinds of evidence that *C. mendica* passes the winter as adult. First, whereas some adults taken September 19 to October 5, inclusive, were gravid and plainly mature in color and hardness, all the females obtained from October 10 to 25 were obviously young, as the nonfunctional state of the ovarioles and the pale soft bodies indicated. In other words, the old reproducing females died before November and the new young females remained sexually inert until spring. Second, collections made in the spring of 1941 and 1942 demonstrated that no stages other than adults of the species appear on the food plant early in the season. Samples taken on May 17 and 23, 1941, consisted entirely of adults, and in 1942, when searches were begun on March 16, only adults occurred on *nyctaginea* from May 2 to 20. Young nymphs in the first and second instars had first made their appearance in numbers on June 1.

Two other field records not my own confirm the fact that the adult winters and likewise bear on the question of winter habitat. Weese (1924) found an adult on October 3, 1921, in the edge of Trelease Woods, and C. O. Esselbaugh, whose present researches at the University of Illinois involve regular collections in Brownfield's Woods, took a female adult on *Aesculus* near the forest margin on April 27, 1942. These instances hint that *mendica,* like many other insects of the open field, migrates into the forest margin in autumn and departs from it again in the spring. Supporting this suggestion are three other facts. First, *nyctaginea* seems still to be restricted

very largely to railroad embankments, hence the *mendica* that appeared in woods margins probably migrated distances of one to two miles from points in the open countryside. Second, although many young adults were developing on *nyctaginea* along railroads in October, 1941, the adult population did not increase there, indicating the imago promptly forsakes the railroad embankment and its food plant after it has stored up a reserve of nutriment in the adipose tissue. Third, the adult bugs appeared tardily on *nyctaginea* in the spring of 1942. Whereas the new shoots sprouted in the week before April 25, *mendica* came back to it during the week following. Moreover, their numbers were very small as compared with the population existing in the same spots in the previous fall. This reduction could, of course, be due to the effects of winter rather than failure to refind the food plant in case they passed the cold season in distant woods. That some mortality results from migration is suggested by the observations that many more adults reappeared in May, 1942, on *nyctaginea* growing along a railroad adjacent to a forest than where the food plant grew along a railroad passing distant from forests. In both situations the bug was abundant in the fall of 1941.

Generations.

My investigations lead me to believe *mendica* completes two, or possibly three, generations yearly in east central Illinois. The first begins with the overwintered adults that reappear on the food plants on railroad embankments in late April and early May. The last of these died on about June 29, 1941, and June 15, 1942. That the wintered females commence laying eggs as soon as they return to *nyctaginea* is shown by the presence of good numbers of mature eggs in the paired oviducts of all females taken on May 2, 1942, the first date on which adults could be found. This fact is of interest in that it indicates spring feeding on *nyctaginea* is not essential to oögenesis, and that the ovarioles probably utilize instead the green adipose matter remaining in the body cavity from the previous fall. Eggs were found in maximum numbers on the food plant on June 1, 1942, and a few remained there unhatched on June 15. On June 1, all the many nymphs present were in the first and second instars, and by June 15, 1941 and 1942, respectively, the nymphal development had progressed as the following analyses of large samples taken on that date show: first instar, 7.0 and 3.0 per cent; second, 20.0 and 15.0; third, 35.0 and 37.0; fourth, 31.0 and 28.0, and fifth, 7.0 and 19.0 per cent. While the nymphal population still remained high on June 28, 1941, but little advance in growth had

been made by that date. On July 4, not only had the number of nymphs fallen off sharply but the percentage of adults increased remarkably to 63.7 from 6.52, where it stood on June 28, showing that the adult, with its storage of reserves, seems to tolerate and survive better than the nymphs the food shortage of those dates.

This decimation resulted in the extremely low population of both nymphs and adults present from July 4 to at least August 9, 1941. The adults at hand during this summer period represent the climax of the first generation and form the parental stock that initiated the second cycle of the year. Because the food plant recovered vegetatively in latter July, 1941, following the maturity of the seed crop, the second generation of *mendica* flourished in September and October, as had the first in May–June. Analysis of the collection of 451 individuals taken on September 19–20, indicate the progress this generation had then made: first instar, 9.1 per cent; second, 15.54; third, 34.85; fourth, 15.76; fifth, 0.66; adults, 24.20 per cent. On September 27 and October 5, nymphs in the third instar continued to predominate in numbers, while on October 11 and 18–20, the fourth instar nymphs constituted the largest per cent, but were followed closely by those of the fifth. The climax of nymphal development was reached on October 25, when the percentages stood at 0.91, 3.19, 12.31, 28.27, 41.04 and 14.3 for the five nymphal instars and adult, respectively. Although the population fell off sharply, due to cold weather and desiccation of the food plant, between October 25 and November 3, as indicated by the 219 and 34 bugs constituting the respective samples of those dates, the fifth instar nymphs continued to predominate. The persistence of first instar nymphs throughout late October and until November 3, and the discovery of a single mature brown egg in a young female otherwise sexually inert on October 25, indicate *mendica* is an opportunistic, indeterminate species, growing and reproducing until halted by unfavorable weather and absence of food.

Finally, the adults of the first generation gradually died off from September 19–20, and earlier, until none remained on and after October 11. At the same time, 40 per cent of the adults found on September 19–20 were new and young, and from October 11 to 25, only such imagos were taken. These enter the winter in a sexually inert state, and oögenesis begins the next spring before the bugs reappear to feed on *nyctaginea*.

If a third generation should prove to characterize *mendica* here, I venture to suggest it develops in July and August, when the population is at a low figure, and weekly samples are therefore so small as to give insufficient and unreliable indication of its occurrence.

References Cited.

Blatchley, W. S. 1926. Heteroptera or true bugs of eastern North America, 246–247.

Gleason, H. A. 1907. A botanical survey of the Illinois river valley sand region, Bul. Ill. St. Lab. Nat. Hist., vol. 7, 149–194.

Hart, C. A. 1907. Zoological studies in the sand regions of the Illinois and Mississippi river valleys, Bul. Ill. St. Lab. Nat. Hist., vol. 7, 195–272.

Stål, Carl 1870. Enumeratio Hemipterorum, Svenska Vet.-Ak. Handl., p. 187.

Standley, Paul C. 1931. Studies of North American plants—V. Field Museum of Natural History, publ. 294, botanical series, vol. 8, no. 5, 293–398.

Weese, A. O. 1924. Animal ecology of an Illinois elm-maple forest, Illinois Biol. Monographs, vol. 9, no. 4, 1–93, pls., tbs., bibl.

Note on Multareis Planifrons Van Duzee.—*Multareis planifrons* Van Duzee (Homoptera, Membracidae) was described from California in 1923 but has never been mentioned in the literature of the family since its original description. It is apparently a rare species and is seldom seen in collections; we have seen only one specimen from any other locality than California and that was a single specimen collected by Dr. J. C. Bradley at San Carlos, Arizona, in 1918. Nothing has ever been reported regarding its life history.

In April, 1942, the writer collected a good series of 48 males, 12 females and 22 nymphs of this unusual species on creosote bushes (*Larrea divaricata* Cav.) in a very limited area in Tucson, Arizona. Egg-slits were numerous on the twigs but none contained eggs, indicating that the eggs had hatched some time before, and the nymphs represented only the last two instars. Apparently it was a little too late in the season to secure the earlier stages. This is a new locality record and there is no question but that creosote is a definite host plant.—W. D. Funkhouser, University of Kentucky, Lexington, Ky.