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Field Population and Flight Activity of Three Hippodamia Species in Eastern South Dakota

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FIELD POPULATIONS AND FLIGHT ACTIVITY OF THREE *HIPPODAMIA* SPECIES IN EASTERN SOUTH DAKOTA

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Doctor of Philosophy, and is acceptable as meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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FIELD POPULATIONS AND FLIGHT ACTIVITY OF THREE *HIPPODAMIA* SPECIES IN EASTERN SOUTH DAKOTA

Abstract

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Twenty-four coccinellid species, excluding the genus *Scymnus*, were collected in eastern South Dakota during the 1969-70 growing seasons. *Hippodamia convergens* Guérin-Méneville, *H. tredecimpunctata* L., and *H. parenthesis* (Say), were the most abundant species found in alfalfa and small grains. Reproduction of *H. convergens* and *H. tredecimpunctata* occurred in alfalfa, oats, spring and winter wheat, and corn. Field observations indicated that the reproductive cycle required approximately 2½ weeks.

The pea aphid, *Macrosiphum pisi* (Harris), the English grain aphid, *M. avenae* (Fabricius), and the corn leaf aphid, *Rhopalosiphum maidis* (Fitch), appeared to be suitable food for these 3 *Hippodamia* species; the brown ambrosia aphid, *M. ambrosiae* (Thomas), was toxic to *H. tredecimpunctata*. Cannibalism and interspecific predation by larvae of *H. convergens* and *H. tredecimpunctata* were observed in the field. Hymenopterous parasitism was observed in *H. convergens*.

Adult coccinellids were found to be very flight active. Flights varied in height which was probably related to distance of flight. Habitat destruction (clipping alfalfa) and food requirements were probable causes for much flight activity. Low recapture of marked lady beetles also supported evidence of their highly mobile nature.

Of the 3 Hippodamia species, H. convergens was found to be the most variable species in size and elytral maculation but was least variable in the ratio of females to males.

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INTRODUCTION

Problems resulting from the widespread, indiscriminate use of insecticides have prompted the search for alternative methods of controlling insect pests at population levels compatible with our increasing demands for food. Integrated control, specific for each crop, shows promise as a future means of coping with insect pest problems on a long-term basis. However, it is imperative that any integrated control program must be based on as complete a knowledge of a particular agrosystem as is feasible.

The objectives of this research were to quantitatively describe field populations and flight activity of the 3 Hippodamia species predominant in South Dakota and to explore some of the biological and ecological factors influencing numbers and activity. A number of other coccinellid species were studied incidently and in comparison with the 3 species of Hippodamia.

LITERATURE REVIEW

Insectivorous Coccinellidae have long been recognized as important biological control agents (Hagen 1962). The unequaled success of the coccidophagous Rodolia cardinalis Muls., reducing infestations of Icerya purchasi Mask., is considered by many as the epitome of biological control; but it is extremely doubtful that such success will be repeated with any species of aphidophagous coccinellid due to a lack of synchrony with their prey.

There is voluminous literature on aphidophagous coccinellids and no attempt will be made here to present a complete review of this work. The reader is referred to the excellent reviews of Balduf (1935), Clausen (1940), Sweetman (1958), Hagen (1962), Hodek (1966), Hagen and Bosch (1968), and Hodek (1970).

Although a great many laboratory tests have been carried out in regard to nutrition, life cycle, and efficiency as predators, very little field work has been done on aphidophagous coccinellids. Perhaps a major reason for this is the difficulty encountered in field experiments; nonetheless, field experiments should be emphasized (Chiang 1966). Some of the more relevant work most directly related to this study shall be briefly considered.

Species Present

The predominant species of coccinellids in corn in Minnesota were found to be Hippodamia tredecimpunctata L., H. convergens

Guérin-Méneville, and Coleomegilla maculata De Geer (Ewert and Chiang 1966); these workers also noted these 3 species in barley, sorghum, and alfalfa. Nineteen species of coccinellids were reported in alfalfa fields in California, indicating the greater diversity of species in that state (Smith and Hagen 1966).

Skuhravý and Novák (1966) point out the relative abundance of Coccinella septempunctata L., C. quinquepunctata L., and Propylaea quattuordecimpunctata L. in sugar beet fields and that these populations were low during 1964 and 1965 and also varied in numbers from year to year. Coccinellids were also demonstrated to vary in density from month to month as well as from year to year in potato fields, sugar beet fields, roadside areas, and the edges of woodlands (Bombosch 1966). Population density of coccinellids also varied between fields of the same crop (Ewert and Chiang 1966). These population densities were not directly related to the numbers of aphids present (Skuhravý and Novák 1966).

Flight Activity

Adult aphidophagous coccinellids are highly flight-active (Hagen 1962) and are in constant search for food or for suitable habitats in which to reproduce (Bänsch 1966). Sluss and Hagen (1966) indicated that as the aphid level dropped below 4 aphids per walnut leaflet, H. convergens left the orchard; Olla abdominalis (Say) remained in the orchard until prey density dropped to 2 aphids per leaflet. These flights were low-altitude and of varying lengths between plants,

intra-field, between fields (Hagen 1962), or between various types of habitat (Bombosch 1966). In a field dispersal study in India in 1966, it was found that when Coccinella septempunctata L. was released the flights varied from a range of 20 to 200 yards at heights varying from 10 to 40 feet; these flights were not directional but were influenced by physical factors (Azam and Ali 1970).

Various techniques have been employed to mark beetles; P^{32}, paint, wing clipping, and wing stickers were used (Azam and Ali 1970). These workers recaptured very few marked specimens, giving further indication of the mobility of these beetles.

Flight of coccinellids at higher altitudes tends to cover longer distances and is usually passive rather than directional. Such flight at higher altitudes may be migrational. Excellent reviews summarize the literature and no attempt is made here to cite specific studies (Dobzhansky 1922 and 1925, Balduf 1935, Hodek and Čerkasov 1958, Hodek 1960, Iperti 1961, Hagen 1962).

Bionomics

Many species of coccinellids live in the same geographic region simultaneously but may inhabit different vegetational types such as trees, shrubs, or meadows (Hodek 1959); several species may share the same crop or even the same plants (Kanervo 1940). Microhabitat studies (Emden 1966) indicated a very unequal distribution within the crop field, with higher densities of coccinellids at the open edges. Ewert and Chiang (1966) reported a vertical stratification

existed between H. convergens, H. tredecimpunctata, and Coleomegilla maculata in 4 Minnesota crops; this stratification was due to light, humidity, and food requirements.

Most predaceous coccinellids are to some extent polyphagous with food demands differing with the species and geographic location (Hodek 1966, Ewert and Chiang 1966). Weeds infested by aphids may serve as a reservoir food supply for many species of lady beetles (Schwarz 1959, Bombosch 1963), but Hodek (1962) points out that many weed-infesting aphids are unsuitable for many species of aphidophagous coccinellids.

The mowing of alfalfa may periodically enhance food-getting for coccinellid larvae by reducing the plant area to be searched, but the adults generally disperse even if a high aphid density exists (Hagen and Sluss 1966). In another study made in central Bohemia in 1964, it was determined that mowing alfalfa did not change the coccinellid density (Skuhravý and Novák 1966); the apparent inconsistency is probably due to different species or variations within species.

Smith (1966) considered sex ratios and differences in size and weight as criteria for evaluation of variation in field populations of several species of coccinellids. He noted, in general, that in species where males were significantly smaller in size than females, the sex ratio was more nearly 1:1. In species where size differences between sexes were negligible, there were disproportionately greater numbers of females.

Hippodamia convergens shows a large variation in size and in elytral maculation. Reduction rather than coalescence of spots is the usual maculation variation. Elytral maculation is an inherited condition (Dobzhansky 1933, Shull 1944).

MATERIALS AND METHODS

Adhesive Traps

Flight activity of adult coccinellids between crops was monitored using cylindrical adhesive traps. Each trap consisted of 6 cylinders (12" long X 6" in diam.) mounted on a 12-foot steel pole (1¼" diam.); cylinders were spaced at 1-foot intervals on the pole with the lowermost one, 1 foot above the ground (Fig. 1).

Groups of 3 traps (18 cylinders) were placed between various crops in eastern South Dakota during the 1969 and 1970 growing seasons. Two groups of traps were located at the Southeast South Dakota Experiment Station near Centerville and 2 groups on the Almos Brothers' farm near Castlewood in the Dry Lake area. The traps in each group were spaced 25 yards apart at 2 sites at each location.

The traps were operated from late April to late November in 1969 and from early May to early December in 1970. Initially each cylinder was coated with Stickem® and periodically maintained to insure uniform adhesiveness. Traps were checked at intervals of 6 to 10 days.

Specimens collected from each trap were placed in 2-dram vials containing a small amount of benzene to remove the adhesive material from the beetles. Labels were placed in vials which specified the date, location, trap number, cylinder number, and the quadrant of the cylinder (N,S,E,W) in which the beetle was caught. These vials were taken into the laboratory for detailed examination.

Additional information recorded for each specimen brought into the laboratory included species identification and width of prothorax. The sex of individuals in Hippodamia species was determined (Fig. 2) and, in H. convergens, the pattern of elytral maculation was recorded (Fig. 3). Variations in elytral maculation were recorded on the basis of missing spots (none absent = 0; 4's absent = 4; all absent = 7; etc.). Spots of reduced size were considered as present, even though a great size reduction was evident.

A B&L® stereoscopic microscope (30X), fitted with an ocular micrometer, was used to make all of these determinations and measurements. All data associated with each specimen were recorded on data sheets and specimens were preserved.

Field Sweeping

Population densities of coccinellids were sampled in small grain and alfalfa fields adjacent to the adhesive traps by using a standard insect sweep net (15" rim diam.; 25" muslin bag depth). Random samples of 200 sweeps were taken each 6 to 10 days throughout the growing season as weather and crop status permitted.

Sweeps of uniform size and depth were made at approximately the same time of day; care was exercised to avoid casting shadows on the sweep path. Sweeping was not done on extremely windy or wet days.

Specimens collected were anesthetized with chloroform, placed in cylindrical pint cartons, and frozen for later examination for

the same types of data as those collected from adhesive traps. Information associated with each of these samples included crop data (height, growth stage), weather information (temperature, cloud cover, wind speed, and direction), and relative numbers of aphids in the crop.

Survey in Corn

Random visual inspection of corn plants was conducted to obtain several types of data pertaining to coccinellids. These surveys were made in the Dry Lake area, for various increments of time, in both drilled and checked fields. Observations were made beginning with knee-high plants until the end of the growing season.

Surveys were made at approximately the same time of day under similar weather conditions. Efforts were made to minimize changes in light intensity by sampling in only 1 row to improve visual acuity and to avoid shadow-casting on plants to be sampled. Each hill of corn was carefully scanned from top to bottom, while remaining in a fixed position, facing the hill.

Data recorded consisted of growth stage of crop, date, general weather condition, relative aphid density, and number of adult and immature forms of lady beetles by species. Egg masses were counted and locations on the plant noted; only those of H. convergens and H. tredecimpunctata could be identified in the field. No specimens were collected from the sampling areas.

Survey of Miscellaneous Habitats

Extensive sampling was done in diverse habitats at locations throughout eastern South Dakota and, to a limited extent, in western Minnesota. At irregular intervals, several crops, roadside vegetation, and prairie and weedy pasture areas, were sampled by sweeping. Several wooded areas and lake shores were also inspected for coccinellid species. These areas provided specimens for mark and release studies, as well as data on the general ecology of lady beetles.

Mark, Release, and Recapture Studies

Flight activity, dispersal behavior, and overwintering potential were studied by releasing several species of adult lady beetles.

Native Species

During the summer of 1969 several thousand lady beetles were collected from wooded areas, lake shores, and corn. These native coccinellids, predominately H. convergens and H. tredecimpunctata, were dot-marked in a cold room with assorted, contrasting colors of quick-drying enamel. All marked beetles were released at the Dry Lake area in a 36-acre field, composed of 12 acres each of alfalfa, corn, and spring wheat; this field was monitored by 1 group (18 cylinders) of adhesive traps and a second group of traps was located approximately 1 mile north. Field sweeping and corn surveys were

also routinely carried out in this field, thus providing recapture potential without increasing normal sampling time.

Laboratory tests, made concurrently, indicated the enamel had good wearing ability and produced no apparent toxic effect to any of the species of lady beetles.

California Lady Beetles

During 1970, approximately 1,050,000 H. convergens, collected from aggregation sites in California, were obtained. These beetles were marked with selected colors of fast-drying, non-toxic (Pactra®) enamel, dispensed by pressurized spray cans. Marking was done in a cold room or in the field at the release site.

The marked beetles were released in the same field (same 3 strips) where native lady beetle releases were made in 1969. Batches of from 6,000 to 10,000 were released throughout these 3 crops at random, releasal sites being at least 50 yards apart. Sites of releases made in early October in alfalfa were marked with lath stakes to facilitate location under snow cover.

A release of an additional 75,000 California beetles was also made in a 5-acre sweet clover field, adjacent to the second group of adhesive traps, where sweeping was also scheduled.

Laboratory Rearing

Laboratory rearing of native lady beetle species, under semi-artificial conditions, was conducted to obtain various biological and ecological data.

Beetles were reared in 1-ounce plastic jelly cups, provided with cardboard lids, at room temperatures fluctuating between 70° and 90° F. Counter space in the laboratory was used for rearing; no attempts were made to control temperature, light intensity or photoperiod.

Blanco® barley, heavily infested with Macrosiphum avenae (Fabricius), the English grain aphid, served as food and moisture for all stages of coccinellids. A surplus of food was fed daily to reduce cannibalism in the larval stages. Aphid-infested barley was cut into small (1" long) pieces in amounts deemed necessary; number, size, and stage of coccinellids determined amounts of food provided. Non-feeding stages were given non-infested barley cuttings.

One container was satisfactory for 1 egg mass (2-51 eggs); after the second molt, larvae were limited to 4 per container. One pair of adults per container was very satisfactory.

Two other aphid species were utilized as food sources employing essentially the same rearing technique. Rhopalosiphum maidis (Fitch), the corn leaf aphid, and M. ambrosiae (Thomas), the brown ambrosia aphid, on corn and goldenrod respectively, were field-collected. Plant parts, heavily infested with these aphids, were cut off and fed to several species of lady beetles.

RESULTS AND DISCUSSION

Species of Coccinellids Collected

Twenty-four species of coccinellids, excluding the genus Scymnus, were collected during this study (Table 1). Hippodamia convergens, H. tredecimpunctata, and H. parenthesis were the only species found consistently in alfalfa and small grain crops. The same species were also present in corn with Coleomegilla maculata, Adalia bipunctata, and Cycloneda munda appearing infrequently; H. parenthesis was collected with much less frequency in corn as compared to alfalfa and small grain crops.

Greater species diversity was evident at the Dry Lake area which is an area of less intensive agriculture than the Centerville area. In addition to greater habitat diversity, the Dry Lake area was much more extensively sampled, especially non-crop areas.

Adhesive traps collected 8 species of coccinellids not detected by other means of sampling. The 4 species (Coccinella novemnotata, Anastis quindecimpunctata, A. ocellata, and Hyperaspis proba) not captured by adhesive traps were collected from wooded areas quite remote from the trap locations.

Numbers of Coccinellids in Crops

Alfalfa

Tables 2-5 show numbers of lady beetles collected by field sweeping in alfalfa. Hippodamia convergens was the most abundant species

found in alfalfa, except at Dry Lake, during the 1970 growing season; no apparent reason for this exception was evident. In all cases, H. parenthesis was the least abundant species of Hippodamia collected from this crop.

Larger numbers of H. tredecimpunctata were present earlier in the growing season, when pea aphids, M. pisi (Harris), were most abundant, suggesting that this coccinellid may serve as the most important aphidophagous species in alfalfa.

Data from alfalfa (Tables 2-5) also indicate that H. convergens and H. tredecimpunctata reproduce in alfalfa and were probably utilizing pea aphids as food. It was not definitely established that H. parenthesis did reproduce in this crop. Reproduction in alfalfa is particularly important as predaceous larvae do not disperse when the crop is mowed (Hagen and Sluss 1966).

Perhaps it would be of value to consider the uniqueness of this study period. During the early spring of 1969, severe flooding of eastern South Dakota could have had drastic effects on overwintering populations of adult lady beetles. A wet, cool spring enhanced the development of high pea aphid population densities. In 1970, spring was exceptionally cold and adult beetles were late in appearing in "set-back" alfalfa crops; very low pea aphid densities were evident throughout the entire alfalfa growing season. Both years had comparatively low numbers of lady beetles.

Small Grains

Sampling conducted in small grains (oats and spring and winter wheat) indicated that the same 3 Hippodamia species were present as the most prevalent lady beetles in these crops (Tables 6-11). Hippodamia convergens and H. tredecimpunctata were the predominant species and probably were the most important predators of the English grain aphid, M. avenae (Fabricius).

Reproduction of H. convergens and H. tredecimpunctata occurred in small grains but it was not definitely established that H. parenthesis did reproduce in these crops. As large numbers of larvae and few adults were collected at numerous times, it seems probable that adults may have dispersed after oviposition.

Corn

Ten species of coccinellids were found in corn fields in the Dry Lake area (Tables 18-19). The more prevalent species were H. convergens and H. tredecimpunctata; H. parenthesis was found only on occasion, in small numbers. Several other species of lady beetles (Coleomegilla maculata, Cycloneda munda, and Adalia bipunctata) were also found in small numbers in corn.

Hippodamia convergens was the most numerous species present in corn and probably exerted the greatest influence on corn leaf aphid, Rhopalosiphum maidis (Fitch), populations. The only other species of importance was H. tredecimpunctata, which may also have influenced numbers of aphids. The habitat appeared to be shared by these species; H. convergens consistently occupied the upper

portion of the corn plants, whereas H. tredecimpunctata was seldom observed above the first corn ear and was most frequently found on aphid-infested grasses between the corn plants. Stratification and the reasons for it have been reported (Ewert and Chiang 1966).

Four species of coccinellids were found to reproduce in corn; these were H. convergens, H. tredecimpunctata, C. maculata, and A. bipunctata, indicating that corn leaf aphids are an adequate food for these species.

Field observations in corn, verified by laboratory data (Table 20), indicated that H. convergens completed its reproductive cycles in approximately 2⅔ weeks. Egg masses, 2-51 eggs each, were usually deposited ventrally on the leaf, in whorls, or on stems of corn plants, and on the grasses or weeds below the corn plants.

Larvae of H. convergens and H. tredecimpunctata were observed as being cannibalistic; the incidence of cannibalism was noted to increase as corn leaf aphid numbers declined. Later instars were observed feeding on pupae, as well as larvae. Cannibalism has been well documented in space-limited laboratory containers, but little information is reported about its occurrence in the field.

Evidence of hymenopterous parasitism was observed only on H. convergens; the low incidence of this type of parasitism probably did not reduce numbers to a great extent. Predation, except by coccinellid larvae (interspecific), was not observed on any coccinellid species.

Miscellaneous Habitats

In late June and early July 1969, large numbers (over 5,000) of H. tredecimpunctata pupae were collected from the understory of a marshy area over-grown with willows; observations indicated that aphids infesting willow trees probably had served as a major food source for the larvae.

Later in July, large build-ups of adults of H. convergens, H. tredecimpunctata, and H. parenthesis occurred along lake shores and lake shore vegetation. Probable reasons for this phenomenon will be considered with regard to flight activity.

A number of crop and natural habitats were sampled by sweeping (Table 12). These data revealed, to an extent, the coccinellid fauna that may occur in mixed vegetation. Hippodamia convergens, and to a lesser extent H. glacialis, were noted as feeding and reproducing on goldenrod (Solidago spp.) heavily infested with the brown ambrosia aphid, M. ambrosiae (Thomas); alternative food sources such as this may serve as important reservoirs for H. convergens during periods of low aphid densities in crops. Hippodamia tredecimpunctata was never found on aphid-infested goldenrod; laboratory tests showed this aphid was toxic to this species of lady beetle. A single specimen of H. parenthesis was noted on an aphid-infested goldenrod but laboratory tests failed to show toxicity.

Adalia bipunctata was frequently observed reproducing and inhabiting aphid-infested willow trees and was noted entering human dwellings (especially window sills) late in autumn. This species is considered

as being primarily arboreal (Ewert and Chiang 1966).

Coccinellid Flight Activity

Coccinellid flight activity between crops is summarized on Tables 21-24. These data show numbers of coccinellids, by species, collected between crops on adhesive traps.

Higher numbers of H. tredecimpunctata were captured on adhesive traps even though H. convergens was the most abundant lady beetle collected directly from crops. Hippodamia parenthesis was the species least frequently captured of the Hippodamia species being compared in this study.

Figures 4-6 graphically present movement between crops as compared to numbers of Hippodamia species collected from crops during the 1970 growing season. These graphs indicate population fluctuations within crops and flight activity between crops. In general, numbers caught on adhesive traps changed as coccinellid populations increased or decreased in a particular crop, indicating that lady beetles were moving from 1 crop to another throughout the growing season.

Mowing of alfalfa, which caused a dramatic reduction of numbers of adult coccinellids in alfalfa, was followed by higher numbers of beetles in trap catches (Fig. 4-5). Movement of coccinellids back into alfalfa, after regrowth of plants, was apparent.

Flight peaks which did not correspond to mowing dates of alfalfa, were probably related to low pea aphid density. Sluss and Hagen

(1966) reported that adult coccinellids disperse unless a minimum density of aphids exist per unit area; the number of aphids necessary to prevent dispersal seems to vary, depending upon the species of coccinellid.

Observations indicated that coccinellid numbers were low in corn early in the growing season and remained low until corn leaf aphids began to increase. As corn leaf aphid populations increased, H. convergens and H. tredecimpunctata also increased in numbers in corn.

Hippodamia convergens was the most frequently collected on adhesive trap cylinders I-III, which were located between 1-6 feet above ground level; only 27.0% were collected from cylinders 7-12 feet above the ground. During the same sampling periods, 31.5% and 51.8% of H. tredecimpunctata and H. parenthesis, respectively, were collected from cylinders 7-12 feet above ground level (Table 25).

These higher catches at lower levels were probably indicative of the greater frequency of short-range roving flight. Flight covering greater distances probably occurs at greater heights.

Large numbers of Hippodamia species were noted along lake shores in eastern South Dakota during July 1969. Reasons for this were not definitely established but it is probable that flights, hindered by strong head winds, caused roving beetles to be forced down before inhabitable areas could be reached; these lakes could have acted as collecting basins, causing beetles to be deposited in "windrows"

along shore lines. Hippodamia parenthesis was present in disproportionately large numbers but H. convergens was the predominant species.

Large numbers of Hippodamia were collected from the Northern Grain Insects Research Laboratory buildings on August 19, 1970. This flight occurred during a humid night, and it appeared that they were attracted by lights. No apparent reason for this flight, and a similar, smaller flight which followed 3 days later, was found. In both cases, H. tredecimpunctata was the most numerous species present. Hippodamia was the only genus represented in these flights.

Mark, Release, and Recapture Studies

Mark and recapture studies were conducted to obtain more specific data about flight activity of coccinellids. All releases were made in crops adjacent to adhesive traps in the Dry Lake area (Tables 26-27). These data indicated that dispersal occurred and recapture was low, even though concentrated efforts were made to recover marked specimens.

Native coccinellids, which were released in 1969, dispersed very rapidly. Only 9 specimens were recaptured of 7,816 released; 4 specimens which were recovered were found in different crops than in which they were released (Table 26). Recaptures occurred in fields very near releasal sites, but a yellow-marked, unidentified specimen was reported seen at a distance of 2 miles from the releasal site. No specimens were recaptured later than 6 days after the releasal date.

Several releases of H. convergens were conducted during 1970; these beetles, collected from aggregation sites, were imported from California (Table 27). Dispersal of these lady beetles differed markedly from native beetles in that complete dispersal required approximately a week and flight tendency was low. Feeding was not apparent at the time of release, although several specimens were observed copulating with both native and California beetles, a few days after releasal.

Thirteen California beetles were recaptured of 675,000 released; 11 of these were collected in flight on adhesive traps; 2 were collected by sweeping in the crop where they were released. No marked specimens were recovered after a lapse of 12 days, suggesting that dispersal may have been complete (Table 27).

A final release of 450,000 marked California lady beetles was made in alfalfa on October 6, 1970. These beetles dispersed only to a limited extent; beetles that remained in aggregation were observed periodically to determine overwintering potential. Observations indicated living aggregations on November 17 but that all beetles were dead by early spring. It is probable that death was related to insufficient stores of food in the fat bodies.

Comparisons of Variations of Hippodamia species

Variations of Sex Ratios

Comparisons of sex ratios of samples of Hippodamia species collected in the field were made in 1969 and 70 (Tables 28-31). Sex

ratios in samples of H. convergens were found to approximate 1:1; samples of H. tredecimpunctata and H. parenthesis were found to have a disproportionately greater number of females. Samples of H. parenthesis showed the most extreme variation in sex ratio; females generally exceeded males by a ratio of 3 or 4 to 1, throughout the study period. Smith (1966) related unbalanced sex ratios to food supply and believed that a greater number of females than males is an advantage in adjusting to increased aphid densities.

Variations in Size

Measurements of prothoracic width in samples of field populations of the 3 Hippodamia species showed (Fig. 7) that females tended to be larger, but more variable in size, than males. This relationship was particularly marked in H. convergens. Least variation in size between the sexes was noted in H. tredecimpunctata. Smith (1966) suggested that degree of difference in size of the sexes could be used as a basis for selecting species with superior capability for survival when food was scarce.

Over-all variation in size in H. convergens covered the greatest range of the 3 species with size variation in H. parenthesis confined to the narrowest range. Dixon's (1959) laboratory experiments showed that variation in size of adults was directly related to larval nutrition. The potential range in variation of size of adults is undoubtedly genetically fixed.

Variations in Elytral Maculation of H. convergens

Specimens of H. convergens collected from adhesive traps and by field sweeping were categorized on the basis of elytral maculation (Table 32). Thirty different patterns of maculation were observed in these collections; 28 of these variants showed spot reduction, whereas only 1 specimen showed coalescence of spots. Data were insufficient to determine whether there was any relationship between pattern of maculation and level of flight activity or behavior.

SUMMARY

Sampling, conducted in a wide variety of habitats during the 1969 and 70 growing seasons, revealed 24 species of coccinellids, excluding the genus Scymnus. Hippodamia convergens Guérin-Méneville, H. tredecimpunctata L., and H. parenthesis (Say) were the most abundant species found consistently in eastern South Dakota crops. Hippodamia convergens and H. tredecimpunctata were most numerous of the genus Hippodamia.

Reproduction of H. convergens and H. tredecimpunctata was observed in alfalfa, small grains, and corn; coccinellid larvae augmented predation on aphids, which suggested that these species probably influenced aphid populations to a greater extent than other coccinellid species.

Reproduction by these species also indicated that pea aphid, Macrosiphum pisi (Harris), English grain aphid, M. avenae (Fabricius), and corn leaf aphid, Rhopalosiphum maidis (Fitch), were suitable food sources. Laboratory tests showed English grain aphid and corn leaf aphid were suitable food for all 3 Hippodamia species but that the brown ambrosia aphid, M. ambrosiae (Thomas), on goldenrod, Solidago species was toxic to H. tredecimpunctata.

Field observations in corn, substantiated in the laboratory, indicated approximately 2½ weeks were necessary for H. convergens and H. tredecimpunctata to complete their reproductive cycles (oviposition to adult).

Observations in corn suggested that sharing of habitats may be more complementary than competitive. Vertical stratification appeared to exist between H. convergens and H. tredecimpunctata, with the former species feeding uppermost on the corn plant and the latter species generally feeding below the lowest ear or on aphid-infested grass between the corn plants.

Cannibalism by larvae was observed in the field; predation (interspecific) probably occurred between several species of coccinellid larvae. Hymenopterous parasitism was noted only in H. convergens but incidence appeared quite low.

Coccinellids were noted to be very flight-active throughout the growing season. Field observations indicated that adults were constantly roving, making short, low-level flights from plant to plant within field crops. Adhesive traps showed movements of lady beetles between crops, from alfalfa during mowing, to alfalfa after plant regrowth, and into corn as corn leaf aphid numbers increased; flights between crops were generally low-altitude (under 6 feet), varying somewhat with species. Higher level flights probably involved greater distances and were probably reflected by large numbers of coccinellids being found along lake shores and on buildings. Species of coccinellids that were collected only by adhesive traps gave further evidence of their highly flight-active nature.

Mark and recapture studies further suggested that coccinellids probably are very flight-active. Small numbers of recaptures, even

though fairly large releases were made and concentrated recovery efforts conducted, indicated that those released dispersed and did not remain in the fields in which releases were made. Native species dispersed immediately whereas H. convergens, collected from California aggregations, remained in aggregation for several days and dispersal was gradual for approximately 1 week.

Comparisons made between the 3 Hippodamia species showed that H. convergens was the most variable in size and elytral maculation. Hippodamia convergens also showed the greatest size variation between males and females but samples indicated a sex ratio of approximately 1:1. Samples of H. parenthesis showed that this species was the most uniform in size but females outnumbered males by a ratio of 3 or 4 to 1.

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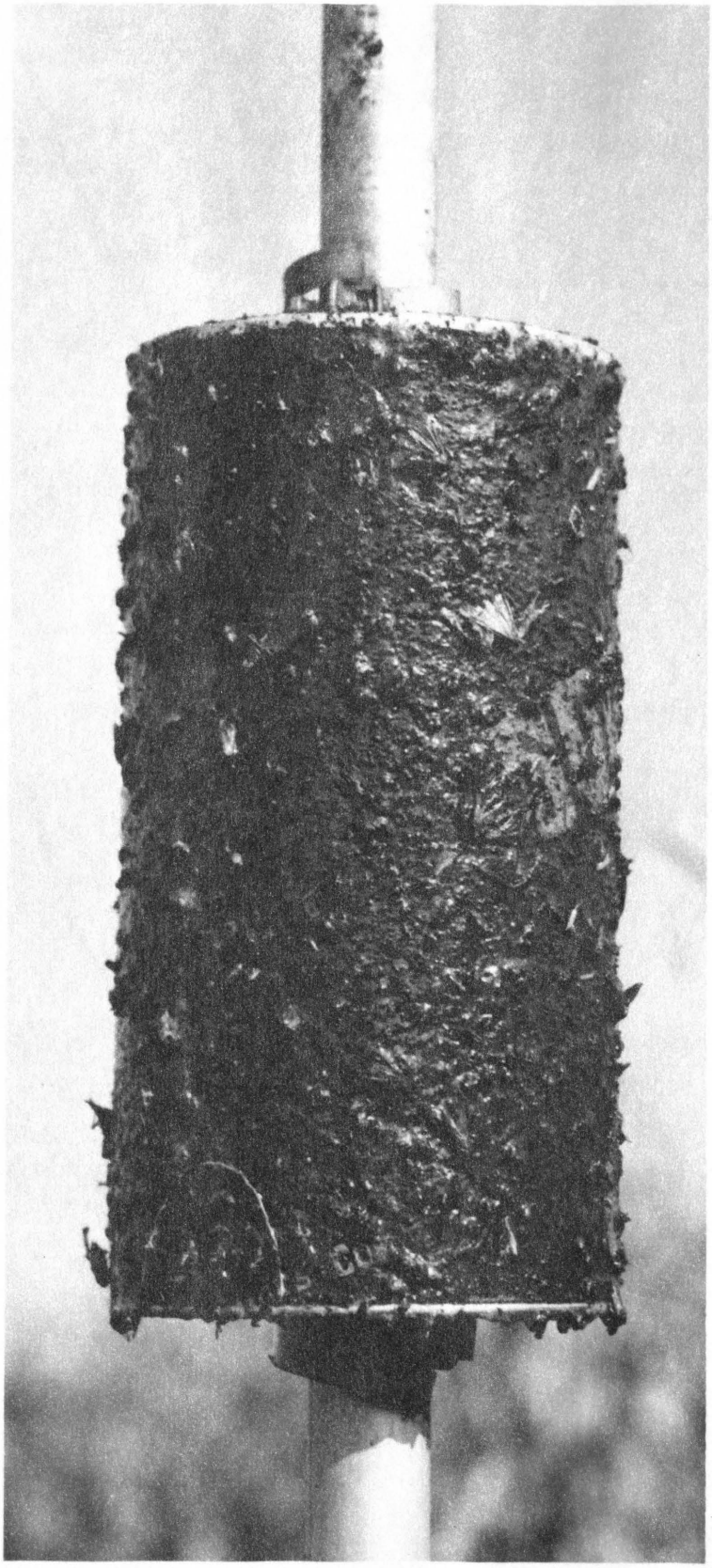
APPENDIX

Figure 1. Adhesive traps.



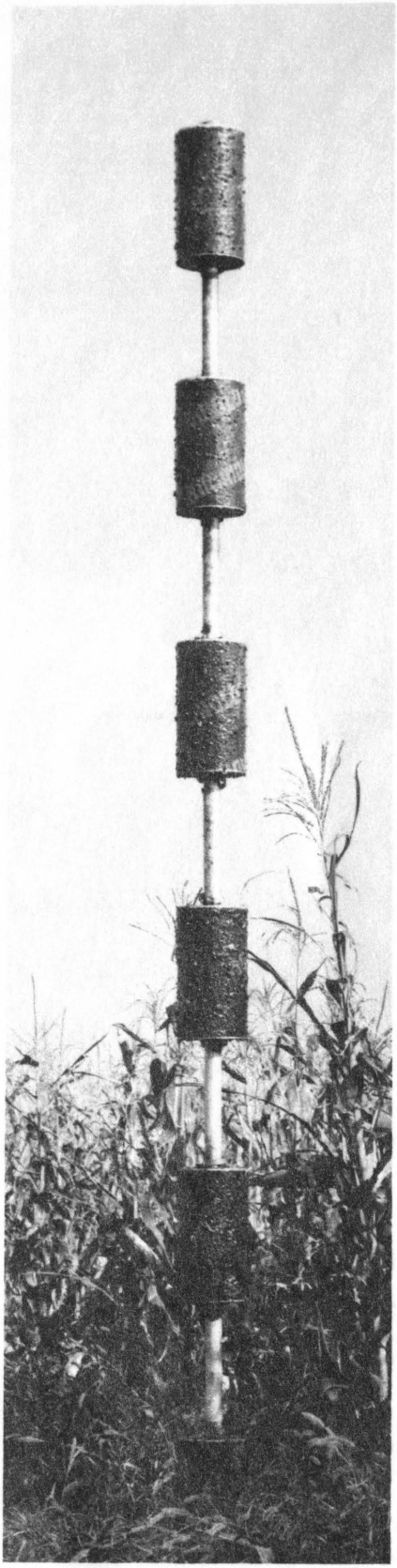
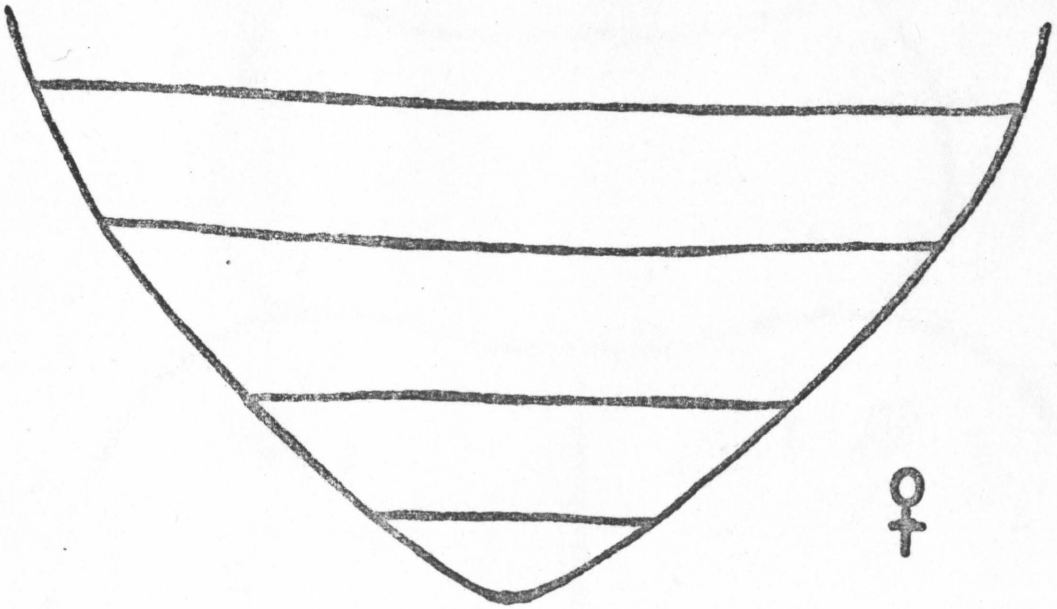


Figure 2. Sexual dimorphism of Hippodamia species.

Ventral view of abdomen; upper diagram - female, lower - male.



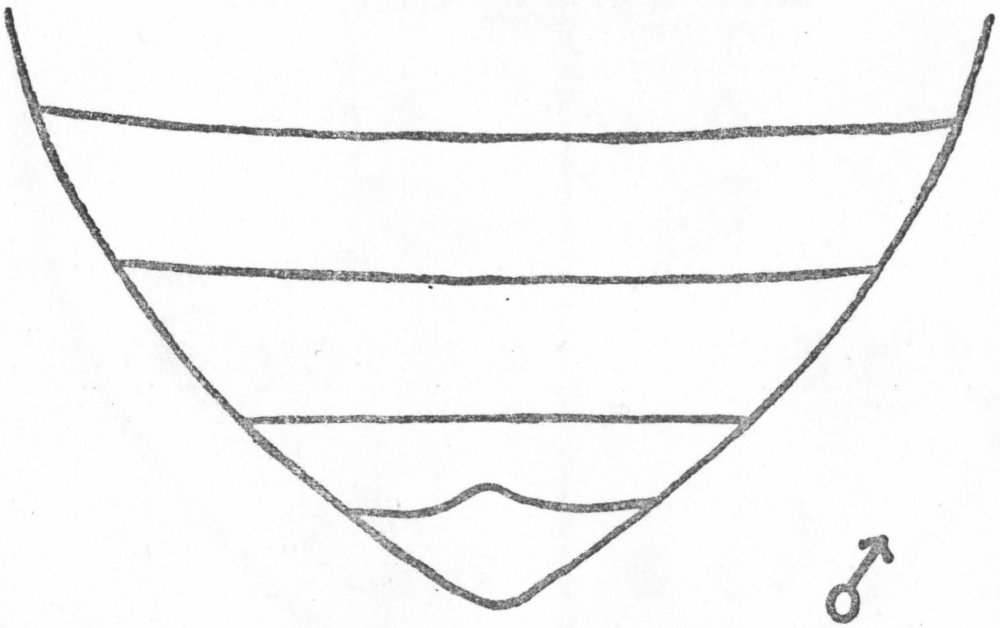


Figure 3. Number system for elytral maculation pattern of H. convergens.

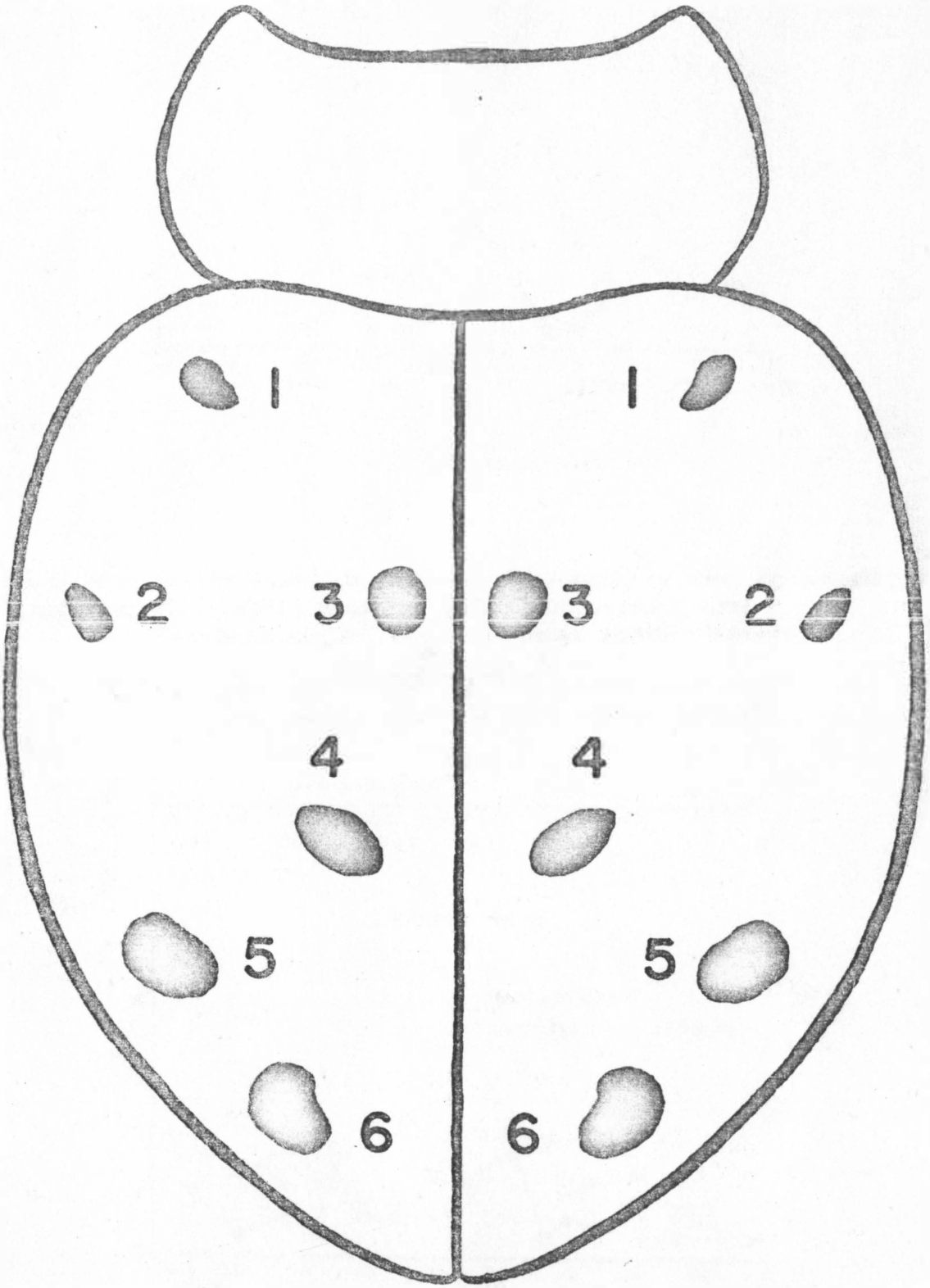

1
1
2
3
3
2
4
4
5
5
6
6

Figure 4. Numbers of Hippodamia species collected on adhesive traps versus numbers swept from adjacent alfalfa, Centerville, South Dakota, 1970.

Data transformed $\sqrt{n + 0.5}$ before plotting. Alfalfa clipping dates: June 10, July 6, Aug. 25.

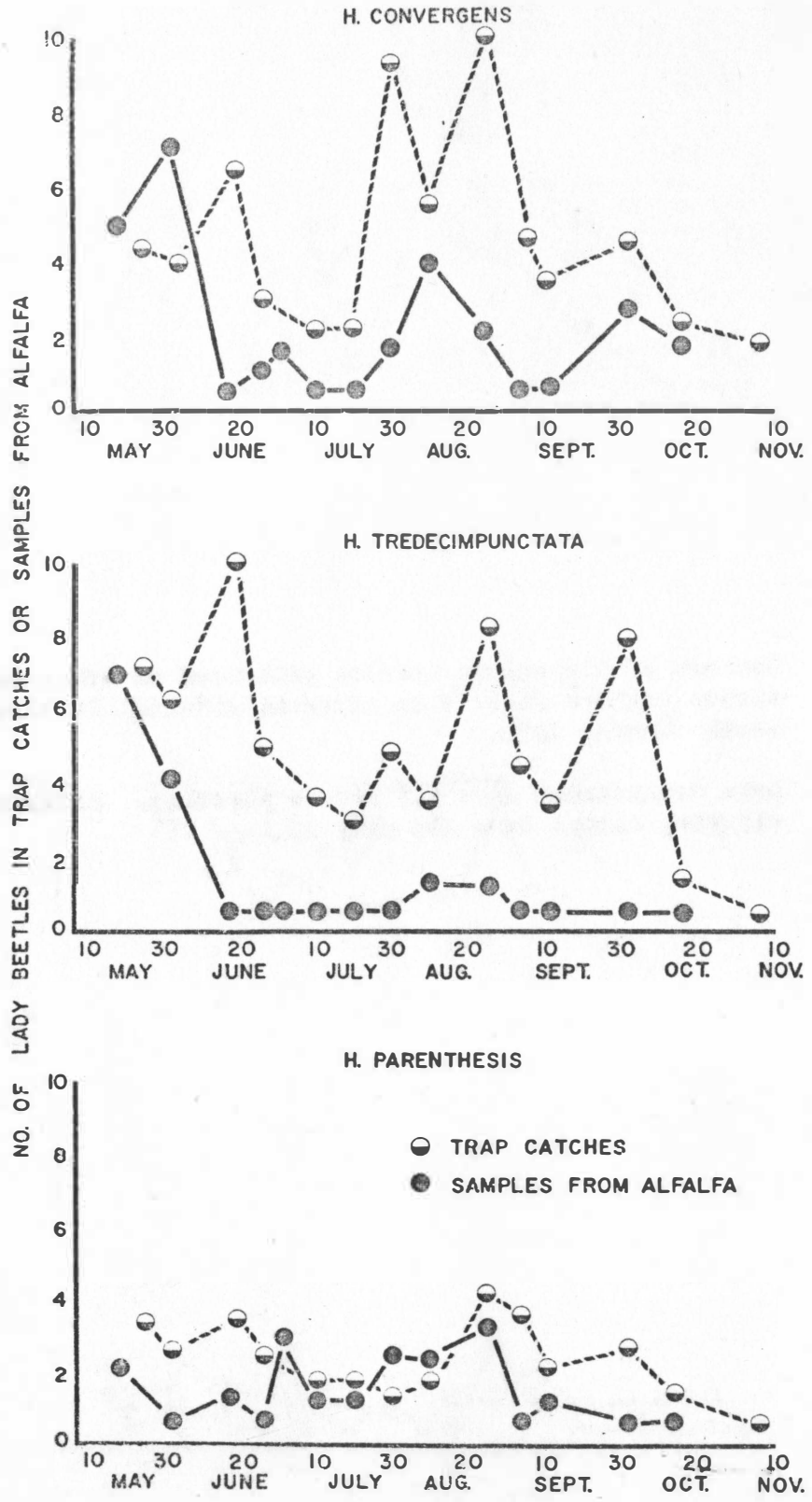

H. CONVERGENS
H. TREDECIMPUNCTATA
H. PARENTHESIS
NO. OF LADY BEETLES IN TRAP CATCHES OR SAMPLES FROM ALFALFA
TRAP CATCHES
SAMPLES FROM ALFALFA
0
2
4
6
8
10
10 30 20 10 30 20 10 30 20 10
MAY JUNE JULY AUG. SEPT. OCT. NOV.

Figure 5. Numbers of Hippodamia species collected on adhesive traps versus numbers swept from adjacent alfalfa, Dry Lake, South Dakota, 1970.

Data transformed $\sqrt{n + 0.5}$ before plotting. Alfalfa clipping dates: June 20, July 22.

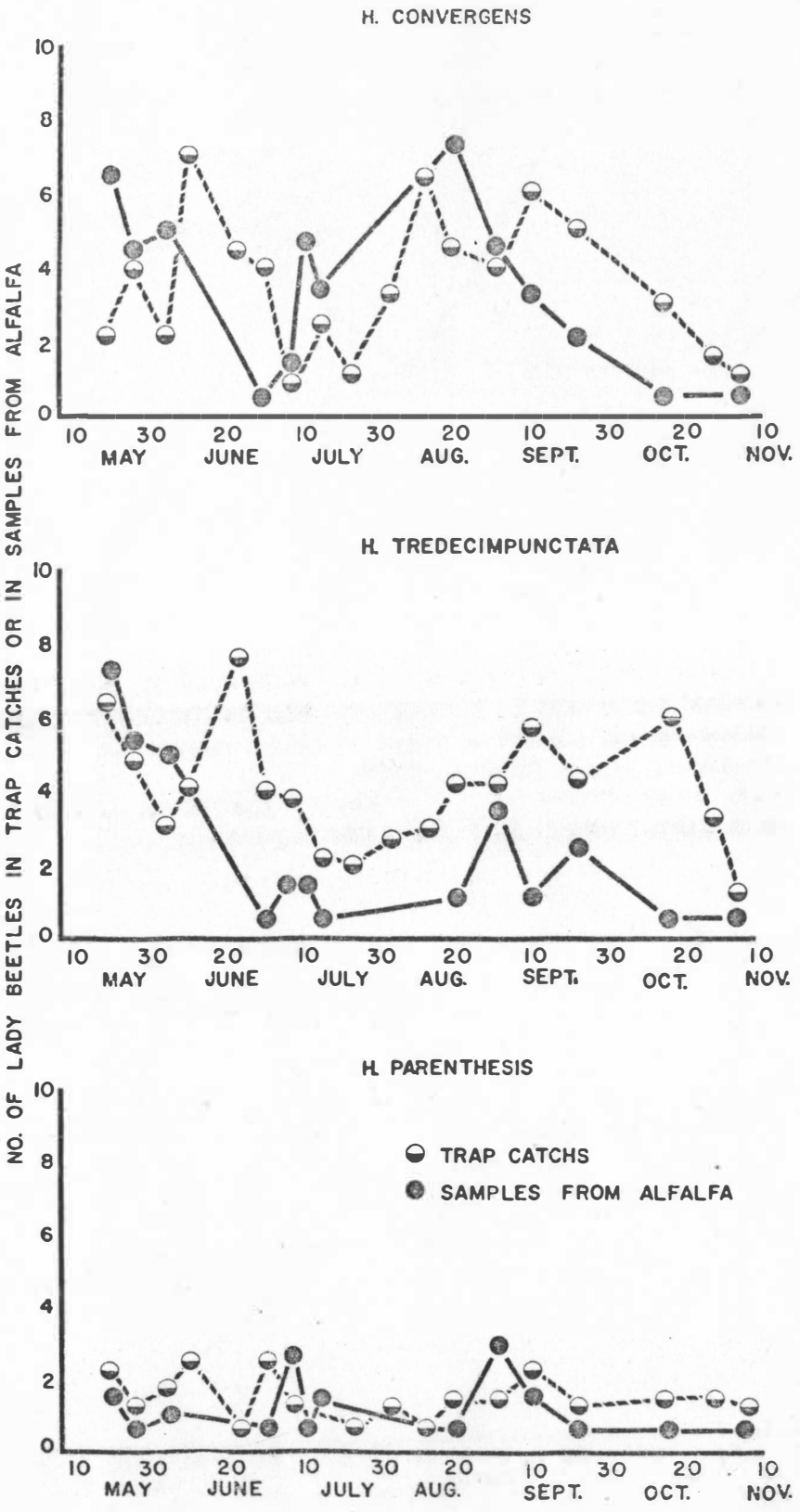

H. CONVERGENS
H. TREDECIMPUNCTATA
H. PARENTHESIS
NO. OF LADY BEETLES IN TRAP CATCHES OR IN SAMPLES FROM ALFALFA
TRAP CATCHS
SAMPLES FROM ALFALFA
0
2
4
6
8
10
10 30 20 10 30 20 10 30 20 10
MAY JUNE JULY AUG. SEPT. OCT. NOV.

Figure 6. Numbers of adult H. convergens and H. tredecimpunctata collected on adhesive traps versus numbers in corn, Dry Lake, South Dakota, 1970.

Data transformed $\sqrt{n + 0.5}$ before plotting.

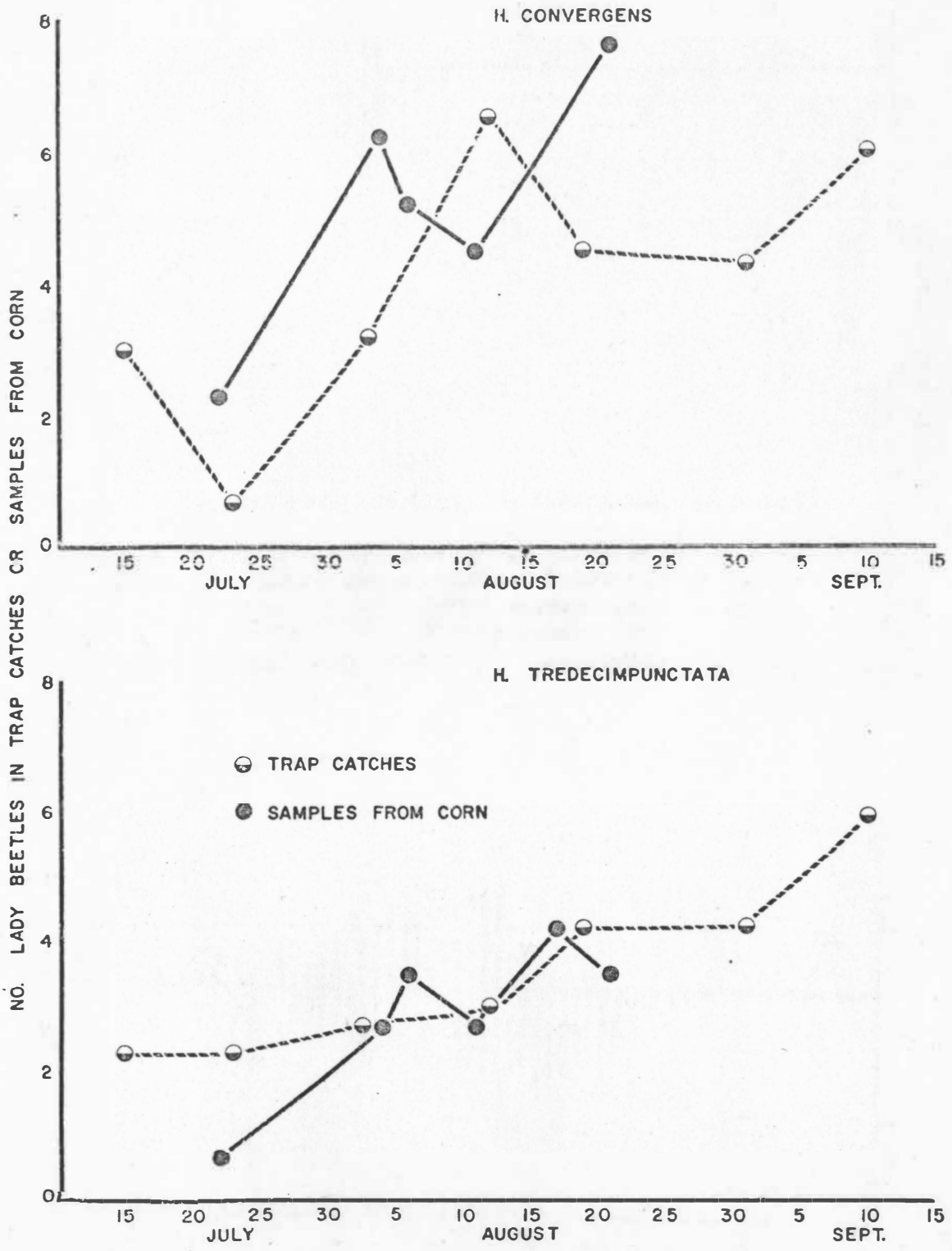

H. CONVERGENS
H. TREDECIMPUNCTATA
TRAP CATCHES
SAMPLES FROM CORN
NO. LADY BEETLES IN TRAP CATCHES OR SAMPLES FROM CORN
0
2
4
6
8
15
20
25
30
5
10
15
20
25
30
5
10
15
JULY
AUGUST
SEPT.

Figure 7. Biometrics of *Hippodamia* species.

Frequency distribution of size classes (prothoracic width) of lady beetles by species and sex. Data transformed $\sqrt{n + 0.5}$ before plotting.

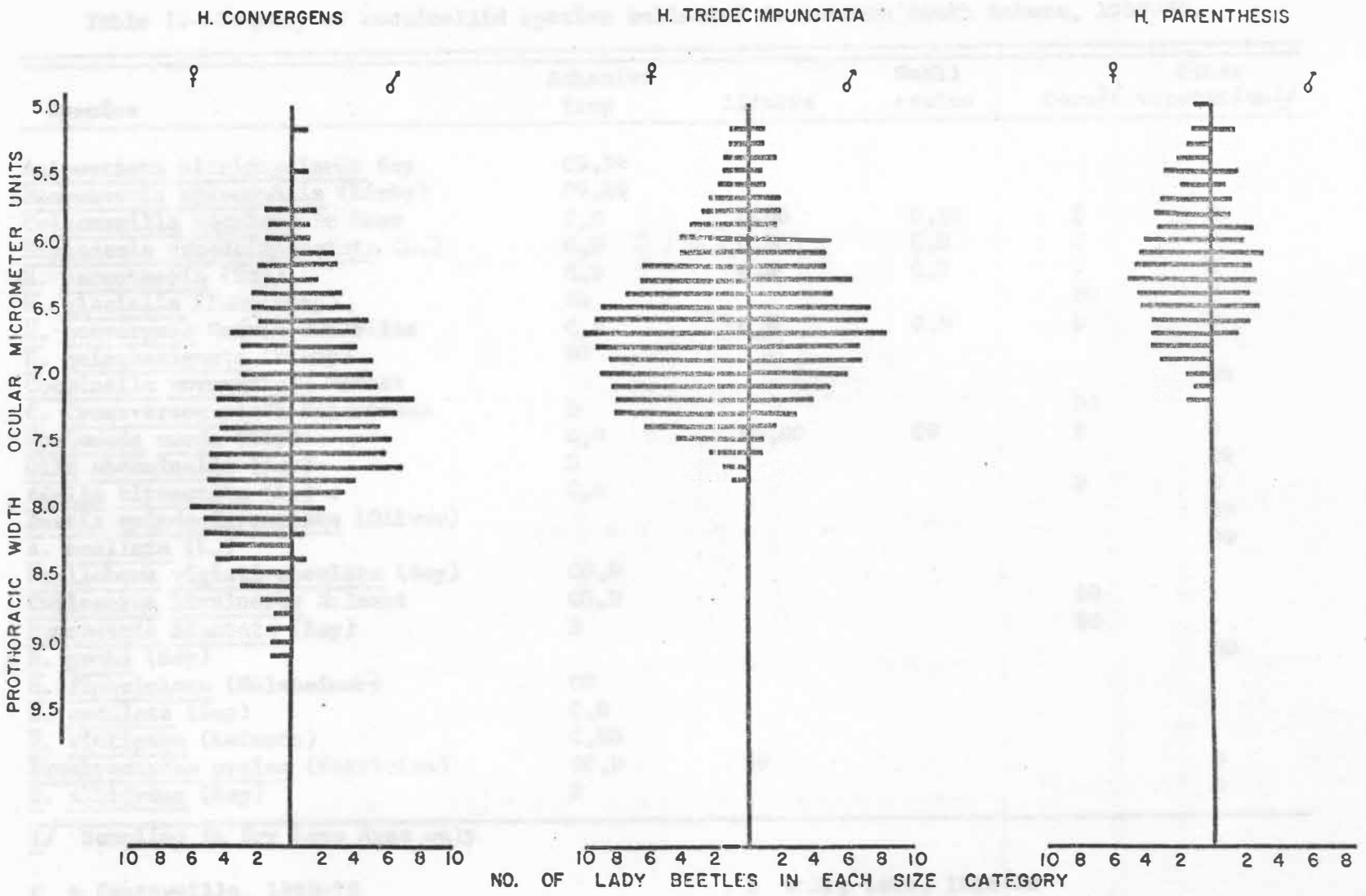

H. CONVERGENS
H. TREDECIMPUNCTATA
H. PARENTHESIS
♀
♂
PROTHORACIC WIDTH OCULAR MICROMETER UNITS
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10 8 6 4 2 2 4 6 8 10
10 8 6 4 2 2 4 6 8 10
10 8 6 4 2 2 4 6 8
NO. OF LADY BEETLES IN EACH SIZE CATEGORY

Table 1.--Summary of coccinellid species collected in eastern South Dakota, 1969-70.

Species	Adhesive trap	Alfalfa	Small grains	Corn 1/	Other vegetation 1/
Anisosticta bitriangularis Say	C9,D9				
Macronaemia episcopalis (Kirby)	C9,D9				
Coleomegilla maculata De Geer	C,D	C,DO	C,D9	D	D
Hippodamia tredecimpunctata (L.)	C,D	C,D	C,D	D	D
H. parenthesis (Say)	C,D	C,D	C,D	D	D
H. glacialis (Fabricius)	DO			DO	D
H. convergens Guérin-Méneville	C,D	C,D	C,D	D	D
H. quinquesignata (Kirby)	DO				
Coccinella novemnotata Herbst					D9
C. transversoguttata Faldermann	D			D9	
Cycloneda munda (Say)	C,D	CO,DO	C9	D	D
Olla abdominalis (Say)	D				D9
Adalia bipunctata (L.)	C,D			D	D
Anatis quindecimpunctata (Oliver)					D9
A. ocellata (L.)					D9
Psyllobora viginti-maculata (Say)	CO,D				
Chilocorus bivulnerus Mulsant	CO,D			D9	
Hyperaspis binotata (Say)	D			D9	
H. proba (Say)					DO
H. fimbriolata (Melsheimer)	CO				
H. undulata (Say)	C,D				
H. vittigera (LeConte)	C,DO				
Brachyacantha ursina (Fabricius)	CO,D	D9			D
B. albifrons (Say)	D				D

1/ Sampling in Dry Lake Area only

C = Centerville, 1969-70
C9 = Centerville, 1969 only
CO = Centerville, 1970 only

D = Dry Lake, 1969-70
D9 = Dry Lake, 1969 only
DO = Dry Lake, 1970 only

Table 2.--Numbers[1/] of coccinellids collected by sweeping alfalfa, Centerville, South Dakota, 1969.

Sampling date	Crop stage	HC	H13	HP	CM	UI
May 6	11"	7	10	1	0	0
May 13	14"	2	10	0	2	0
May 20	14"	3	13	0	1	0
May 27	16"	0	0	0	0	0
June 3	16"	6	10	0	0	0
June 10	16"	3	7	0	0	0
July 8	20"	144	43	10	2	5
July 15	Crop clipped - No samples taken					
July 22	4"	0	0	0	0	0
Aug. 5	6"	0	0	0	0	0
Aug. 12	10"	0	0	1	0	0
Aug. 25	15"	1	1	3	0	0
Aug. 28	18"	1	0	0	0	0
Sept. 2	20"	2	2	2	0	0
Sept. 3	Crop clipped - No samples taken					
Sept. 9	4"	1	0	0	0	0
Sept. 16	4"	0	0	0	0	0
Sept. 24	8"	3	0	0	0	0
Oct. 1	8"	3	0	1	0	0
Oct. 8	10"	0	0	0	0	0
Nov. 11	10"	1	0	0	0	0
Totals		177	96	18	5	5

1/ Number/200 sweeps

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
CM = Coleomegilla maculata
UI = Undetermined immatures

Table 3.--Numbers[1/] of coccinellids collected by sweeping alfalfa, Dry Lake, South Dakota, 1969.

Sampling date	Crop stage	HC	H13	HP	BU	UI
May 8	Rain - No samples taken					
May 15	12"	0	0	0	0	0
May 20	14"	0	0	0	0	0
May 28	14"	0	0	0	0	0
June 5	16"	0	1	0	0	0
June 9	16"	0	1	0	0	0
June 26	Crop clipped - No samples taken					
June 30	4"	0	0	0	0	1
July 9	12"	18	12	1	1	0
July 18	20"	43	5	15	0	192
July 18	20"	26	3	5	1	278
July 21	Crop clipped - No samples taken					
July 31	6"	1	0	0	0	0
Aug. 6	8"	0	0	0	0	0
Aug. 13	12"	0	0	0	0	0
Aug. 18	16"	0	0	0	0	0
Aug. 25	18"	0	2	0	0	0
Sept. 3	20"	1	0	0	0	0
Sept. 10	20"	1	1	0	0	0
Sept. 14	Crop clipped - No samples taken					
Sept. 17	4"	0	0	0	0	0
Sept. 23	4"	0	0	0	0	0
Sept. 30	4"	0	0	0	0	0
Oct. 7	4"	0	0	0	0	0
Oct. 23	8"	3	0	0	0	0
Totals		94	30	21	2	471

1/ Number/200 sweeps

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
BU = Brachyacantha ursina
UI = Undetermined immatures

Table 4.--Numbers[1/] of coccinellids collected by sweeping alfalfa, Centerville, South Dakota, 1970.

Sampling date	Crop stage	HC	H13	HP	CM	CYM	UI
May 18	14"	27	49	4	18	0	0
June 2	16"	54	17	0	3	1	0
June 9	Crop clipped - No samples taken						
June 17	6"	0	0	1	0	0	0
June 26	10"	1	0	0	0	0	0
July 1	14"	3	0	8	2	0	0
July 6	Crop clipped - No samples taken						
July 10	4"	0	0	1	0	0	0
July 20	6"	0	0	1	0	0	0
July 30	12"	3	0	6	1	0	1
Aug. 10	14"	15	1	5	4	1	0
Aug. 25	16"	4	1	11	2	0	4
Aug. 26	Crop clipped - No samples taken						
Sept. 4	4"	0	0	0	0	0	0
Sept. 11	4"	0	0	1	0	0	0
Oct. 2	6" dry	7	0	0	0	0	0
Oct. 16	6" dry	3	0	0	0	0	0
Totals		117	68	46	30	2	5

1/ Number/200 sweeps

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
CM = Coleomegilla maculata
CYM = Cycloneda munda
UI = Undetermined immatures

Table 5.--Numbers[1/] of coccinellids collected by sweeping alfalfa, Dry Lake, South Dakota, 1970.

Sampling date	Crop stage	HC	H13	HP	CM	CYM	UI	IL
May 20	10"	44	52	2	0	0	0	0
May 26	15"	21	28	0	0	0	0	0
June 5	18"	24	26	1	0	1	0	0
June 20	Crop clipped - No samples taken							
June 30	4"	0	0	0	0	0	0	0
July 7	12"	2	2	7	0	0	0	0
July 11	15"	22	2	0	3	1	1	0
July 15	16"	13	0	2	0	1	0	0
July 27	Crop clipped - No samples taken							
Aug. 20	10"	52	1	0	0	1	0	0
Sept. 1	14"	23	12	9	4	0	0	13-HC 1-H13
Sept. 10	15"	11	1	2	0	0	1	0
Sept. 22	16" dry	4	13	0	2	0	0	0
Oct. 15	16" dry	0	0	0	0	0	0	0
Nov. 15	16" dry	0	0	0	0	0	0	0
Totals		137	216	23	9	4	2	14

1/ Number/200 sweeps

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
CM = Coleomegilla maculata
CYM = Cycloneda munda
UI = Undetermined immatures
IL = Identified larvae

Table 6.--Numbers[1/] of coccinellids collected by sweeping winter wheat, Centerville, South Dakota, 1969.

Sampling date	Crop stage	HC	H13	HP	CM	UL
May 13	8"	2	2	0	2	0
May 20	12"	0	2	0	4	0
May 27	16"	0	0	0	0	0
June 3	20"	0	0	0	0	0
June 10	26"	0	0	0	0	3
June 20	30" headed	2	1	1	0	20
July 20	30" headed	13	25	4	0	0
July 22	30" ripe	0	0	0	0	0
Totals		17	30	5	6	23

1/ Number/200 sweeps

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
CM = Coleomegilla maculata
UL = Undetermined larvae

Table 7.--Numbers[1/] of coccinellids collected by sweeping spring wheat, Dry Lake, South Dakota, 1969.

Sampling date	Crop stage	HC	H13	HP	UL
June 9	8"	0	0	0	3
June 16	10"	0	0	0	7
June 19	14"	0	0	0	13
June 26	14"	1	0	0	2
June 30	16"	3	0	0	1
July 9	22"	45	28	2	0
July 18	24" headed	0	2	1	0
July 18	24" headed	7	1	1	1
July 18	24" headed	10	4	2	0
July 23	24" headed	2	3	1	1
July 24	24" headed	10	1	3	0
July 31	24" headed	1	0	1	0
Aug. 6	24" ripe	1	0	0	0
Totals		80	39	11	28

1/ Number/200 sweeps

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
UL = Undetermined larvae

Table 8.--Numbers[1/] of coccinellids collected by sweeping oats, Centerville, South Dakota, 1969.

Sampling date	Crop stage	HC	H13	HP	CM	CYM	UL
May 10	10"	0	0	0	0	0	1
May 20	16"	2	0	0	0	0	7
July 8	20"	14	21	21	1	1	0
July 14	Sprayed with Sevin® - No samples taken						
July 22	22"	0	0	0	0	0	0
Aug. 5	24" ripe	0	0	0	0	0	0
Totals		16	21	21	1	1	8

1/ Number/200 sweeps

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
CM = Coleomegilla maculata
CYM = Cycloneda munda
UL = Undetermined larvae

Table 9.--Numbers[1/] of coccinellids collected by sweeping oats, Dry Lake, South Dakota, 1969.

Sampling date	Crop stage	HC	H13	HP	CM	UL
June 30	14"	0	0	0	1	0
July 9	16"	6	1	0	0	1
July 23	24"	4	1	0	0	0
July 31	Headed-ripe	1	0	0	0	0
Totals		11	2	0	1	1

1/ Number/200 sweeps

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
CM = Coleomegilla maculata
UL = Undetermined larvae

Table 10.--Numbers[1/] of coccinellids collected by sweeping oats, Centerville, South Dakota, 1970.

Sampling date	Crop stage	HC	H13	CM
June 2	12"	1	2	0
June 19	19"	3	5	1
June 26	25"	1	0	0
July 1	25"	0	0	0
July 17	25" ripe	0	0	1
Totals		5	7	2

1/ Number/200 sweeps

HC = Hippodamia convergens
H13 = H. tredecimpunctata
CM = Coleomegilla maculata

Table 11.--Numbers[1/] of coccinellids collected by sweeping spring wheat, Dry Lake, South Dakota, 1970.

Sampling date	Crop stage	HC	H13	HP
June 5	7"	2	1	0
June 23	18"	6	1	0
June 30	19"	0	1	0
July 7	22"	1	0	0
July 15	24" ripe	0	0	0
Totals		9	3	0

1/ Number/200 sweeps

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis

Table 12.--Relative frequencies[1/] of coccinellids collected by sweeping several crops and natural habitats in eastern South Dakota, 1969.

Location (county)	Sampling date	Vegetation	HC	H13	HP	HG	BU	BA	UL	IL
Deuel	June 20	Spring wheat	0	0	0	0	0	0	0	0
Deuel	June 20	Spring wheat	0	0	0	0	0	0	0	0
Deuel	June 20	12"-Goldenrod	0	0	0	0	0	0	0	1[2/]
Grant	June 20	12"-Oats	0	0	0	0	0	0	0	0
Grant	June 20	22"-Sweet clover	1	0	1	0	0	0	0	0
Grant	June 20	16"-Red clover	0	1	0	0	0	0	0	0
Grant	June 20	3"-Alfalfa	1	0	0	0	0	0	0	0
Deuel	June 20	10"-Oats	0	0	0	0	0	0	2	0
Grant	June 20	24"-Alfalfa	0	0	0	0	0	0	0	0
Grant	June 20	24"-Alfalfa	0	0	0	0	0	0	0	0
Brookings	June 24	Roadside vegetation	0	0	1	0	57	34	0	0
Hamlin	June 26	22"-headed Timothy	0	0	0	0	2	1	0	0
Hamlin	June 26	12"-Oats	0	0	0	0	0	0	0	0
Brookings	June 27	Goldenrod grasses	0	0	0	0	1	0	0	0
Deuel	June 28	Red clover	0	0	0	0	0	0	0	0

Table 12.--Continued.

Location (county)	Sampling date	Vegetation	HC	H13	HP	HG	BU	BA	UL	IL
Deuel	June 28	Oats-headed	2	0	0	0	0	0	0	0
Deuel	June 28	Sweet clover	0	0	5	0	0	2	0	0
Deuel	June 28	Willow-Goldenrod	0	0	0	0	0	0	0	0
Deuel	June 28	Roadside vegetation	0	0	0	0	0	3	0	0
Brookings	July 9	36"-Barley	11	3	1	0	0	0	0	0
Brookings	July 9	36"-Barley	5	4	2	0	0	0	0	0
Brookings	July 9	Wheat	24	8	4	0	0	0	5	0
Grant	July 23	14"-Alfalfa	1	0	1	0	0	0	0	0
Grant	July 23	Alfalfa	1	0	0	0	2	0	0	0
Grant	July 23	Goldenrod	1	0	4	2	0	0	0	0
Grant	July 23	23"-Oats	5	2	0	0	0	0	0	0
Grant	July 23	22"-Oats	3	1	0	0	0	0	0	0
Grant	July 23	Flax-Mustard	4	0	0	0	0	0	0	0

1/ Number/200 sweeps
2/ 1 - H. parenthesis

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
HG = H. glacialis
BU = Brachyacantha ursina
BA = B. albifrons
UL = Undetermined larvae
IL = Identified larvae

Table 13.--Summary of relative frequencies of adult coccinellids in corn, Dry Lake, South Dakota, 1969.

Survey date	Search time (hr)[1/]	HC	H13	HP	CYM	AB	CM	CT	CB	HB
July 28	1	6	8	1	0	0	0	0	0	0
July 30	3	7	1	0	0	0	0	0	0	0
July 31	2	14	4	0	0	1	0	0	0	0
Aug. 1	1	38	25	0	1	0	0	0	0	0
Aug. 2	3	29	10	0	0	0	0	0	0	0
Aug. 4	2	33	33	1	0	1	1	0	0	0
Aug. 5	4	197	52	6	1	16	0	1	0	0
Aug. 7	4	29	29	0	0	18	0	0	0	0
Aug. 8	5	209	107	16	0	8	0	1	0	0
Aug. 11	2	59	62	0	3	9	0	0	1	0
Aug. 12	1	21	15	1	1	1	0	1	0	0
Aug. 13	2	20	54	0	0	0	0	0	0	0
Aug. 14	3	119	134	0	1	10	0	0	0	0
Aug. 26	1	17	3	0	0	0	0	0	0	0
Sept. 3	1	31	28	1	2	0	0	0	0	0
Sept. 4	2	54	61	1	0	1	0	0	0	0
Sept. 8	1¾	8	28	0	0	0	0	0	0	0
Sept. 10	1¾	12	42	0	1	0	4	0	0	1
Sept. 12	1	11	29	0	1	0	0	0	0	0
Sept. 19	1½	11	1	0	1	0	1	0	0	0
Totals	42	925	726	27	12	65	6	3	1	1

1/ Approximately 250 hills/hr

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
CYM = Cycloneda munda
AB = Adalia bipunctata
CM = Coleomegilla maculata
CT = Coccinella transversoguttata
CB = Chilocorus bivulnerus
HB = Hyperaspis binotata

Table 14.--Numbers of adult and immature stages of H. convergens in corn, Dry Lake, South Dakota, 1969.

Survey date	Search time (hr)1/	Adults	Pairs in copula	Egg mass	Larvae	Pupae
July 28	1	6	0	0	0	0
July 30	3	7	0	1	0	0
July 31	2	14	3	0	0	0
Aug. 1	1	38	0	0	0	0
Aug. 2	3	29	4	0	0	0
Aug. 4	2	33	0	0	0	0
Aug. 5	2	115	20	2	0	0
Aug. 5	2	82	4	3	0	0
Aug. 7	4	29	0	1	7	4
Aug. 8	2	31	1	1	0	1
Aug. 8	3	178	23	1	0	0
Aug. 11	2	59	3	0	0	0
Aug. 12	1	21	0	0	0	0
Aug. 13	2	20	1	0	2	3
Aug. 14	3	119	18	2	0	0
Aug. 26	1	17	0	0	2	1
Sept. 3	½	1	0	0	0	0
Sept. 3	1	31	0	0	2	1
Sept. 4	2	54	0	0	6	0
Sept. 8	1¼	8	0	0	1	0
Sept. 10	1¼	12	0	0	0	0
Sept. 12	1	11	0	0	0	0
Sept. 19	1½	11	0	0	0	0
Total	42	926	77	11	20	10

1/ Approximately 250 hills/hr

Table 15.--Numbers of adult and immature stages of *H. tredecimpunctata* in corn, Dry Lake, South Dakota, 1969.

Survey date	Search time (hr)[1/]	Adults	Pairs in copula	Egg mass	Larvae	Pupae
July 28	1	8	0	0	0	0
July 30	3	1	0	0	0	0
July 31	2	4	0	0	0	0
Aug. 1	1	25	0	0	0	0
Aug. 2	3	10	0	0	0	0
Aug. 4	2	33	0	0	0	0
Aug. 5	2	30	0	0	0	0
Aug. 5	2	22	0	0	0	0
Aug. 7	4	29	0	0	7	4
Aug. 8	2	44	0	0	1	0
Aug. 8	3	63	2	0	0	0
Aug. 11	2	62	1	0	1	0
Aug. 12	1	15	0	0	0	0
Aug. 13	2	54	0	0	2	3
Aug. 14	3	134	1	1	6	0
Aug. 26	1	3	0	0	4	0
Sept. 3	½	2	0	0	0	0
Sept. 3	1	26	0	0	0	3
Sept. 4	2	61	0	0	3	0
Sept. 8	1¾	28	0	0	0	0
Sept. 10	1¾	42	0	0	0	0
Sept. 12	1	29	0	0	0	0
Sept. 19	1½	1	0	0	0	0
Totals	42	726	4	1	24	10

1/ Approximately 250 hills/hr

Table 16.--Numbers of miscellaneous adult coccinellids in corn, Dry Lake, South Dakota, 1969.

Survey date	Search time (hr)[1]	HP	CYM	AB	CM	CT	CB	HB
July 28	1	1	0	0	0	0	0	0
July 31	2	0	0	1	0	0	0	0
Aug. 1	1	0	1	0	0	0	0	0
Aug. 2	3	0	1	0	0	0	0	0
Aug. 4	2	1	0	1	1	0	0	0
Aug. 5	4	6	1	16[2]	0	1	0	0
Aug. 7	4	0	0	18	0	0	0	0
Aug. 8	5	15	0	8[3]	0	1	0	0
Aug. 11	2	0	3	9	0	0	1	0
Aug. 12	1	1	1	3[3]	0	1	0	0
Aug. 14	3	0	1	10	0	0	0	0
Sept. 3	1	1	2	0	0	0	0	0
Sept. 4	2	1	0	1	0	0	0	0
Sept. 10	1¼	0	1	0	4	0	0	1
Sept. 12	1	0	1	0	0	0	0	0
Sept. 19	1½	0	1	0	1	0	0	0
Totals	42	26	13	67	6	3	1	1

1/ Approximately 250 hills/hr
2/ 2 pair adults in copula
3/ 1 pair adults in copula

HP = Hippodamia parenthesis
CYM = Cycloneda munda
AB = Adalia bipunctata
CM = Coleomegilla maculata
CT = Coccinella transversoguttata
CB = Chilocorus bivulnerus
HB = Hyperaspis binotata

Table 17.--Summary of relative frequencies of adult coccinellids in corn, Dry Lake, South Dakota, 1970.

Survey date	Numbers/2-hour search time[1/]						
	HC	H13	HP	CM	CYM	HG	AB
July 22	5	0	0	2[2/]	0	0	0
July 28	108	34	0	1	0	0	0
Aug. 3	43	13	0	0	0	0	0
Aug. 4	36	7	0	1	0	1	0
Aug. 5	18	6	0	1	1	0	0
Aug. 6	54	24	0	4	2	1	0
Aug. 11	19	7	0	3	0	0	0
Aug. 14	89	24	0	0	1	0	0
Aug. 17	80	17	0	5[3/]	0	0	0[4/]
Aug. 20	64	18	0	2	0	0	0
Aug. 21	123	24	0	8	0	0	0
Aug. 31	67	26	2	6	1	0	0
Totals	706	200	2	33	5	2	0

1/ Approximately 250 hills/hr
2/ In copula
3/ 9 larvae in addition
4/ 1 pupa in addition

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
CM = Coleomegilla maculata
CYM = Cycloneda munda
HG = H. glacialis
AB = Adalia bipunctata

Table 18.--Numbers of adult and immature stages of H. convergens in corn, Dry Lake, South Dakota, 1970.

Survey date	Numbers/2-hour search time[1/]				
	Adults	Pairs in copula	Egg masses	Larvae	Pupae
			HAYTI FIELD		
July 28	108	19	2	0	0
Aug. 3	43	6	1	340	6
Aug. 5	18	0	1	440	80
Aug. 14	89	0	0	31	343
Aug. 20	64	0	0	1	6
Aug. 31	67	0	0	0	0
Totals	389	25	4	812	435
			ALMOS FIELD		
July 22	5	0	0	0	0
Aug. 4	36	1	0	3	2
Aug. 6	31	3	2	157	4
Aug. 6	23	1	1	167	3
Aug. 11	19	3	0	323	78
Aug. 17	80	0	0	118	267
Aug. 21	59	0	0	17	94
Aug. 21	64	0	0	28	137
Totals	317	8	3	813	585

1/ Approximately 250 hills/hr

Table 19.--Numbers of adult and immature stages of H. tredecimpunctata in corn, Dry Lake, South Dakota, 1970.

Survey date	Numbers/2-hour search time[1/]				
	Adults	Pairs in copula	Egg masses	Larvae	Pupae
			HAYTI FIELD		
July 28	34	0	0	0	0
Aug. 3	13	0	0	31	0
Aug. 5	6	0	0	53	7
Aug. 14	24	0	0	3	67
Aug. 20	18	0	0	0	1
Aug. 31	26	0	0	0	0
Totals	121	0	0	87	75
			ALMOS FIELD		
July 22	0	0	0	0	0
Aug. 4	7	0	0	0	0
Aug. 6	18	0	0	2	5
Aug. 6	6	0	0	2	8
Aug. 11	7	0	0	57	17
Aug. 17	17	0	0	8	26
Aug. 21	18	0	0	2	5
Aug. 21	6	0	0	2	8
Totals	79	0	0	73	69

1/ Approximately 250 hills/hr

Table 20.--Life history statistics for H. convergens under laboratory conditions.

Life stage	n	$\bar{X} \pm S\bar{x}$	Range
Number eggs/mass	123	19.85±0.570	2-51
Days-egg stage	56	3.21± .077	3-4
Days-1st instar	56	2.29± .067	1-3
Days-2nd instar	56	1.98± .082	1-3
Days-3rd instar	56	1.57± .098	1-3
Days-4th instar	56	4.33± .089	3-5
Days-pupal stage	56	5.00± .076	4-6
Days-oviposition to adult	56	18.32± .161	16-20

Table 21.--Relative frequencies of coccinellids collected on adhesive traps, Centerville, South Dakota, 1969.

Survey date	HC	H13	HP	CM	CYM	AB	HU	HV	ME	ANB
April 29	0	4	8	0	0	0	1	0	0	0
May 6	6	16	16	1	0	0	1	0	0	0
May 9	1	5	10	2	0	0	0	0	0	0
May 13	0	2	2	0	0	0	0	0	0	0
May 20	0	5	6	3	0	0	2	0	2	1
May 23	3	1	2	0	0	0	0	0	0	0
May 27	0	6	3	3	0	1	1	0	0	0
May 29	6	10	3	0	1	0	1	0	0	0
June 3	0	2	1	0	0	0	0	0	0	0
June 5	0	1	4	0	0	0	0	0	0	0
June 10	0	5	1	2	0	0	0	2	0	0
June 13	0	1	2	0	0	0	0	4	0	0
June 17	2	2	3	1	0	0	0	5	0	0
June 20	1	0	1	0	0	1	0	0	0	0
July 8	12	25	24	1	0	4	1	1	0	0
July 14	13	37	10	1	0	5	0	0	0	0
July 17	18	11	5	0	1	2	0	0	0	0
July 22	6	11	7	1	0	1	0	0	0	0
July 30	4	6	3	1	1	1	0	0	0	0
Aug. 5	5	1	3	0	0	0	0	0	0	0
Aug. 12	8	31	3	0	0	2	0	0	0	0
Aug. 25	6	30	4	3	1	4	0	0	0	0
Aug. 27	6	2	1	0	0	0	0	0	0	0
Sept. 2	33	29	2	0	0	0	0	0	0	0
Sept. 9	29	13	3	0	0	0	0	0	0	0
Sept. 16	4	4	1	0	0	0	0	0	0	0
Sept. 24	4	7	2	0	0	0	0	0	0	0
Oct. 1	1	10	8	16	0	0	0	0	0	0
Oct. 8	1	2	0	8	0	0	5	0	0	0
Oct. 23	5	11	2	1	0	0	0	0	0	0
Nov. 5	0	15	0	0	0	0	1	0	0	0
Nov. 28	6	34	3	8	0	1	0	0	0	0
Totals	180	339	143	52	4	22	13	12	2	1

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
CM = Coleomegilla maculata
CYM = Cycloneda munda
AB = Adalia bipunctata
HU = H. undulata
HV = H. vittigera
ME = Macronaemia episcopalis
ANB = Anisosticta bitriangularis

Table 22.--Relative frequencies of coccinellids collected on adhesive traps, Dry Lake, South Dakota, 1969.

Survey date	HC	H13	HP	CM	AB	HB	HU	CB	ME	ANB	BU	BA	CT	OA	PV	CYM
May 2	0	0	1	0	5	0	1	0	0	0	0	0	0	0	0	0
May 13	0	1	1	0	1	15	0	0	0	0	0	0	0	0	0	0
May 20	0	0	0	0	0	5	2	1	1	1	1	0	0	0	0	0
May 28	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0
June 2	0	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0
June 5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
June 9	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0
June 16	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
June 19	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
June 26	2	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0
July 7	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0
July 9	6	7	0	0	3	0	0	0	0	0	1	1	0	0	0	0
July 16	6	8	0	0	5	0	0	0	0	0	0	0	1	0	0	0
July 18	8	7	5	0	2	0	0	0	0	0	6	0	0	0	0	0
July 23	4	9	0	0	3	0	0	0	0	0	0	0	0	0	0	0
July 31	0	0	1	0	0	0	1	1	0	0	0	0	0	0	2	0
Aug. 6	0	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Aug. 12	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug. 13	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug. 18	3	32	0	0	7	0	0	1	0	0	0	0	0	1	0	0
Aug. 25	6	27	0	0	4	0	0	0	0	0	0	0	0	0	0	1
Sept. 3	0	12	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Sept. 10	0	14	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Sept. 17	1	15	0	2	0	0	1	0	0	0	0	0	0	0	0	0
Sept. 23	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Sept. 30	1	4	1	6	0	0	1	0	0	0	0	0	0	0	0	1
Oct. 7	0	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0
Oct. 9	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Oct. 17	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Oct. 21	0	5	0	3	1	0	0	0	0	0	0	0	0	0	0	0
Nov. 4	0	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Nov. 24	4	150	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Totals	41	313	16	13	41	30	10	6	1	2	10	2	1	1	2	2

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
CM = Coleomegilla maculata
AB = Adalia bipunctata
HB = Hyperaspis binotata
HU = H. undulata
CB = Chilocorus bivulnerus
ME = Macronaemia episcopalis
ANB = Anisosticta bitriangularis
BU = Brachyacantha ursina
BA = B. albifrons
CT = Coccinella transversoguttata
OA = Olla abdominalis
PV = Psyllobora viginti-maculata
CYM = Cycloneda munda

Table 23.--Relative frequencies of coccinellids collected on adhesive traps, Centerville, South Dakota, 1970.

Survey date	HC	H13	HP	CM	CYM	AB	HU	PV
May 25	19	50	11	16	0	1	5	0
June 2	15	38	5	4	4	0	4	0
June 19	43	101	12	19	9	5	3	0
June 26	12	25	6	4	0	4	1	0
July 10	4	13	3	2	1	1	0	0
July 20	4	9	3	1	0	0	1	0
July 30	86	23	2	1	0	0	1	0
Aug. 10	31	13	3	10	2	2	0	1
Aug. 25	104	69	18	18	10	0	2	0
Sept. 4	22	20	13	8	3	0	0	0
Sept. 11	6	12	4	2	1	0	0	0
Oct. 2	21	62	7	46	0	0	1	0
Oct. 16	5	2	0	2	0	0	1	0
Nov. 6	3	0	0	0	0	0	0	0
Totals	375	437	87	133	31	13	19	1

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
CM = Coleomegilla maculata
CYM = Cycloneda munda
AB = Adalia bipunctata
HU = H. undulata
PV = Psyllobora viginti-maculata

Table 24.--Relative frequencies of coccinellids collected on adhesive traps, Dry Lake, South Dakota, 1970.

Survey date	HC	H13	HP	CM	CYM	AB	HU	PV	BU	BA	CB	HB	HV	CT	HG	HQ	HF	OA
May 19	4	42	5	3	0	0	10	0	0	0	0	0	0	0	0	0	0	0
May 26	20	25	1	1	0	0	4	0	0	0	0	1	0	0	0	0	0	0
June 4	10	9	3	0	0	0	3	2	0	0	0	1	0	0	0	0	1	0
June 10	63	19	6	0	2	0	1	2	5	1	0	1	0	0	0	0	0	0
June 23	40	60	0	2	1	0	3	0	0	0	0	0	1	2	1	0	0	0
June 30	20	17	6	0	1	0	0	0	6	1	0	0	0	0	0	0	0	0
July 7	5	15	1	1	1	1	0	0	2	0	0	0	0	0	0	1	0	0
July 15	9	5	0	0	2	2	0	1	0	0	0	0	0	0	0	0	0	0
July 23	0	5	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0
Aug. 3	10	7	1	0	1	1	0	1	0	0	1	0	0	0	0	0	0	1
Aug. 12	42	6	0	3	4	2	0	5	0	0	2	3	0	0	0	0	0	0
Aug. 19	20	17	2	1	4	1	0	4	0	0	0	0	0	0	0	0	0	0
Sept. 1	18	17	2	1	2	0	0	3	0	0	0	0	0	0	0	0	0	0
Sept. 10	35	36	4	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
Sept. 22	25	19	1	135	2	1	2	0	0	0	0	0	0	0	0	0	0	0
Oct. 14	14	45	2	49	2	2	0	2	0	0	0	0	0	0	0	0	0	0
Oct. 27	5	82	2	2	0	7	2	0	0	0	0	0	0	0	0	0	0	0
Nov. 5	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	341	428	37	198	29	18	25	20	14	2	3	6	1	2	1	1	1	1

HC = Hippodamia convergens
H13 = H. tredecimpunctata
HP = H. parenthesis
CM = Coleomegilla maculata
CYM = Cycloneda munda
AB = Adalia bipunctata
HU = H. undulata
PV = Psyllobora viginti-maculata
BU = Brachyacantha ursina
BA = B. albifrons
CB = Chilocorus bivulnerus
HB = Hyperaspis binotata
HV = H. vittigera
CT = Coccinella transversoguttata
HG = H. glacialis
HQ = H. quinquesignata
HF = H. fimbriolata
OA = Olla abdominalis

Table 25.--Height of flight of the 3 major Hippodamia species.

Species	Location	Year	Number trapped 1-6'	Number trapped 7-12'
H. convergens	Centerville	1969	139	41
	Dry Lake	1969	23	18
	Centerville	1970	291	84
	Dry Lake	1970	231	110
Totals			684	253
% 7-12'				27.0%
H. tredecimpunctata	Centerville	1969	221	118
	Dry Lake	1969	186	127
	Centerville	1970	329	107
	Dry Lake	1970	302	126
Totals			1038	478
% 7-12'				31.5%
H. parenthesis	Centerville	1969	75	68
	Dry Lake	1969	2	3
	Centerville	1970	44	43
	Dry Lake	1970	10	27
Totals			131	141
% 7-12'				51.8%

Table 26.--Summary of mark-recapture studies of native coccinellids, Dry Lake, South Dakota, 1969.

Date	Release number	Species	Release crop	Recapture comments[1/]
July 3	400	H13	Alfalfa	
July 5	600	H13	Alfalfa	3 recaptured July 9, sweeping spring wheat adjacent
July 6	1000	H13	Alfalfa	1 recaptured July 9, sweeping same field
July 8	350	H13	Oats	
July 15	1680	HC	Spring wheat	1 (species unknown) reported in alfalfa, 2 miles west of release site by farmer, July 16 (probably released July 15)
July 15	560	HP	Spring wheat	
July 16	280	HC	Spring wheat	
July 16	40	H13	Spring wheat	
July 16	40	HP	Spring wheat	1 H. convergens found dead in corn, July 16 (released on July 15 or 16)
July 16	160	HC+H13	Spring wheat	
Aug. 1	69	HC	Corn	
Aug. 1	48	H13	Corn	
Aug. 1	1	CYM	Corn	
Aug. 4	68	HC	Corn	
Aug. 4	80	H13	Corn	
Aug. 6	435	HC+H13	Corn	2 H. convergens recaptured Aug. 11 same field
Aug. 9	209	HC	Corn	2 recaptured Aug. 11, same field
Aug. 9	108	H13	Corn	
Aug. 9	16	HP	Corn	
Aug. 9	8	AB	Corn	
Aug. 11	59	HC	Corn	
Aug. 11	62	H13	Corn	
Aug. 11	9	AB	Corn	
Aug. 11	3	CYM	Corn	
Aug. 11	1	CB	Corn	
Aug. 12	40	HC	Corn	
Aug. 12	40	HG	Corn	
Aug. 12	34	H13	Corn	
Aug. 12	12	HP	Corn	
Aug. 12	12	CM	Corn	
Aug. 12	8	CYM	Corn	
Aug. 12	5	AB	Corn	
Aug. 13	21	HC	Corn	
Aug. 13	15	H13	Corn	
Aug. 13	3	HP	Corn	
Aug. 14	20	HC	Corn	
Aug. 14	54	H13	Corn	
Aug. 14	119	HC	Corn	
Aug. 14	10	AB	Corn	
Aug. 14	134	H13	Corn	
Aug. 14	1	CYM	Corn	

Table 26.--Continued.

Date	Release number	Species	Release crop	Recapture comments 1/
Aug. 27	300	HC+H13	Corn	
Aug. 28	470	HC	Corn	
Sept. 5	84	HC	Corn	
Sept. 5	86	H13	Corn	
Sept. 5	4	CYM	Corn	
Sept. 5	1	HP	Corn	
Sept. 5	1	AB	Corn	
Sept. 12	12	HC	Corn	
Sept. 12	38	H13	Corn	
Sept. 12	4	CM	Corn	
Sept. 12	1	CYM	Corn	
Sept. 12	1	HB	Corn	
Total	7,816			

1/ None recaptured after 6 days or after Aug. 11

HC = Hippodamia convergens
H13 = H. tredecimpunctata
AB = Adalia bipunctata
CYM = Cycloneda munda
CB = Chilocorus bivulnerus
HG = H. glacialis
HP = H. parenthesis
CM = Coleomegilla maculata
HB = Hyperaspis binotata

Table 27.--Summary of mark-recapture studies of California H. convergens, Dry Lake, South Dakota, 1970.

Date	Release number	Release crop	Recapture comments[1/]
June 17	75,000	Spring wheat	3 recaptured June 23, adhesive trap
June 18	75,000	Sweet clover	2 recaptured June 23, sweeping same field
Aug. 7	75,000	Corn	2 recaptured Aug. 12 on adhesive traps and 1 recaptured Aug. 19, adhesive traps
Sept. 8	150,000	Corn	
Sept. 10	300,000	Corn	5 recaptured Sept. 22, adhesive traps
Oct. 6	450,000[2/]	Alfalfa	
Total	1,125,000		

1/ None recaptured after 14 days
2/ Dispersal studies not made; none overwintered

Table 28.--Sex ratios of *Hippodamia* species, Centerville, South Dakota, 1969.

	Apr	May	June	July	Aug	Sept	Oct	Nov	Total
				H. convergens					
Total		16	3	53	25	70	7	6	180
Female		5	1	29	13	34	2	4	88
Male		11	2	24	12	36	5	2	92
% Female		31.3	33.3	54.7	52.0	48.6	28.6	66.7	48.9
				H. tredecimpunctata					
Total	4	45	11	90	64	24	23	49	310
Female	4	33	4	59	33	18	17	27	195
Male	0	12	7	31	31	6	6	22	115
% Female	100.0	73.3	36.4	65.6	51.6	75.0	73.9	55.1	62.9
				H. parenthesis					
Total	8	42	12	49	11	8	10	3	143
Female	6	28	6	36	8	6	6	3	99
Male	2	14	6	13	3	2	4	0	44
% Female	75.0	66.7	50.0	73.5	72.7	75.0	60.0	100.0	69.2

Table 29.--Sex ratios of *Hippodamia* species, Dry Lake, South Dakota, 1969.

	May	June	July	Aug	Sept	Oct	Nov	Total
				H. convergens				
Total		2	24	9	2	0	4	41
Female		1	7	3	0	0	2	13
Male		1	17	6	2	0	2	28
% Female		50.0	29.2	33.3	0.0	0.0	50.0	31.7
				H. tredecimpunctata				
Total	2	2	31	71	46	7	154	313
Female	0	2	13	22	31	5	102	175
Male	2	0	18	49	15	2	52	138
% Female	0.0	100.0	41.9	31.0	64.7	71.4	66.2	55.9
				H. parenthesis				
Total	2	2	9	0	2	1		16
Female	2	1	8	0	0	1		12
Male	0	1	1	0	2	0		4
% Female	100.0	50.0	88.9	0.0	0.0	100.0		75.0

Table 30.--Sex ratios of *Hippodamia* species, Centerville, South Dakota, 1970.

	May	June	July	Aug	Sept	Oct	Nov	Total
				H. convergens				
Total	19	70	94	133	28	26	3	373
Female	12	36	37	63	16	15	2	181
Male	7	34	57	70	12	11	1	192
% Female	63.2	51.4	39.4	47.4	57.1	57.7	66.7	48.5
				H. tredecimpunctata				
Total	50	163	45	82	32	64		436
Female	28	113	35	64	25	45		310
Male	22	50	10	18	7	19		126
% Female	56.0	69.3	77.8	78.0	78.1	70.3		71.1
				H. parenthesis				
Total	11	23	8	21	17	7		87
Female	9	19	5	19	11	7		70
Male	2	4	3	2	6	0		17
% Female	81.8	82.6	62.5	90.5	64.7	100.0		80.5

Table 31.--Sex ratios of *Hippodamia* species, Dry Lake, South Dakota, 1970.

	May	June	July	Aug	Sept	Oct	Nov	Total
				H. convergens				
Total	24	133	14	52	78	19		340
Female	10	78	5	11	48	6		170
Male	14	55	9	41	30	13		170
% Female	41.7	58.6	35.7	21.2	61.5	31.6		50.0
				H. tredecimpunctata				
Total	67	105	25	30	72	127	2	428
Female	45	62	16	23	59	83	1	289
Male	22	43	9	7	13	44	1	139
% Female	67.2	59.0	64.0	76.7	81.9	65.4	50.0	67.5
				H. parenthesis				
Total	6	15	1	3	7	4	1	37
Female	5	11	1	3	6	4	1	31
Male	1	4	0	0	1	0	0	6
% Female	83.3	73.3	100.0	100.0	85.7	100.0	100.0	83.8

Table 32.--Comparison of patterns of elytral maculations of *H. convergens* in samples from field populations.

	Centerville, South Dakota				Dry Lake, South Dakota			
	Adhesive traps		Sweeping		Adhesive traps		Sweeping	
Variants	1969	1970	1969	1970	1969	1970	1969	1970
1	11	12	7	2	14	1	6	12
1 2	0	0	1	0	0	0	0	0
1 2 3	0	0	0	0	1	0	1	0
1 2 4	0	0	0	1	0	0	0	0
1 2 4 5 6	0	1	0	0	1	0	0	1
1 3	0	0	1	0	0	0	0	0
1 3 4 5 6	3	2	1	0	1	0	0	2
1 3 4 6	0	1	0	0	0	0	0	0
1 3 5 6	0	0	0	0	0	0	2	0
1 4	2	0	2	0	1	0	1	1
1 4 5	0	1	0	0	0	0	0	0
1 4 5 6	3	4	5	2	4	2	4	5
1 4 6	0	0	0	0	2	1	2	0
1 5	0	1	0	0	0	0	1	0
1 5 6	1	3	2	2	0	0	2	2
1 6	1	4	2	1	0	0	0	3
2	2	1	0	1	4	0	0	0
2 3	1	2	0	1	1	0	0	0
2 3 4 5 6	0	0	0	0	1	0	0	0
3	0	1	3	1	1	0	0	0
3 6	0	0	0	0	0	0	1	0
4	0	2	2	0	1	0	0	4
4 5 6	0	3	0	0	0	0	1	3
4 6	0	0	0	1	2	0	1	0
5	0	0	1	0	0	0	0	0
5 6	1	1	1	1	2	0	1	0
6	1	1	5	1	1	1	3	4
7	3	14	5	1	4	0	0	4
1 coalesed	0	0	0	0	1	0	0	0