Journal of the Lepidopterists' Society
35(3), 1981, 179–193

THE DAKOTA SKIPPER, *HESPERIA DACOTAE* (SKINNER): RANGE AND BIOLOGY, WITH SPECIAL REFERENCE TO NORTH DAKOTA[1]

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ABSTRACT. *Hesperia dacotae* (Skinner) (Lepidoptera: Hesperiidae) biology, ecology, behavior, and distribution have been examined in North Dakota and correlated with information from the remainder of the species' range. The skipper is oligolectic, utilizing *Ratibida columnifera* (Nutt.) and *Erigeron strigosus* Muhl. (both Asteraceae) with greatest frequency. The skipper requires calcareous prairie conditions and has niche requirements similar to that of the lily, *Zigadenus elegans* Pursh, although its life history is completely independent of the plant. The skipper appears to require a range of precipitation-evaporation ratios between 60 and 105 and a soil pH between 7.2 and 7.8. The larva is described and illustrated. The normal overwintering stage is probably the fourth instar larva.

Hesperia dacotae (Skinner) is a northern Great Plains species associated with calcareous (alkaline) prairies. These prairies are poorly suited for most agricultural purposes and usually serve as hayland or pasture. Calcareous prairies are of a fragile nature and even carefully controlled grazing rapidly alters the flora through soil impaction and selective feeding, making it unsuitable for the skipper.

Habitat destruction, through intensive agriculture or grazing, has so restricted the species' range that it has been proposed for Endangered Species consideration. The Water and Power Resources Service (formerly the Reclamation Bureau) needed a survey for the Dakota skipper to ensure no habitat would be lost as a result of the Garrison Diversion Project. This paper is derived from a report submitted to the Water and Power Resources Service, Bismarck, North Dakota. Garrison Diversion Units (GDU's) were intensively surveyed, but much of North Dakota was visited during the course of this study.

METHODS

The GDU's were initially surveyed by airplane. This was necessary as the entire flight span of the adult skipper is a brief 3–4 weeks. From the air it was possible to eliminate areas that showed no potential, i.e., areas under cultivation and overgrazed sites. Each portion of the GDU (see Fig. 7) was criss-crossed every four miles by plane. The main advantage of the aerial survey was to define the portion of the GDU which required an "on-the-ground" examination.

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Potential habitat discovered by the aerial survey was marked on a map, and I visited each of these sites at least once. Potential sites included areas that have obviously been used for hay (hay bales still present) or were ungrazed and usually had gravel pits nearby (indicators of required gravelly subsurface conditions). These general requirements were based on observations I have made since 1968 on several North Dakota and Minnesota populations of the Dakota skipper.

The ground survey was accomplished between 8 July and 25 July 1979. These dates represent the flight period of the skipper for 1979 only. Over the years I have observed a range of flight periods beginning as late as 8 July or as early as 16 June. 1979's emergence date was established by watching an extant colony, the Felton prairie, Clay Co., Minnesota, every sunny day until the skipper began flying (Fig. 9). Once the flight period began, all GDU's not subjected to cultivation were traversed by automobile. This allowed for surveillance of considerably more territory than just the GDU's as much of eastern North Dakota was crossed while in transit. All likely sites, as viewed from the road or from the plane, were covered on foot and prevalent plants and animals were recorded. Each general area of the GDU (see map, Fig. 7) was visited three times. Persistent overcast conditions in the Oakes region (southeastern North Dakota) necessitated additional visits and even then conditions were not as ideal as is desirable. However, practically no suitable habitat was available and only one colony was discovered. Immediately south of Oakes, in South Dakota, considerable habitat is available and this area shows more promise than past records indicate.

BIOLOGY OF *HESPERIA DACOTAE*

Dakota skipper adults fly in June and July, and early spring climatic conditions determine their emergence date. Both sexes emerge on the same day. Mating takes place as early as the first day of emergence and both sexes will mate more than once. Females continue to lay eggs throughout their adult life, which is estimated at two–four weeks in nature. Eggs require 7–20 days to hatch, depending on temperature, with 10 days being typical. Eggs are laid on any broad surface with some preference given to broad-leaved plants, especially *Astragalus* spp. Grasses have not been observed to be used for oviposition sites.

The newly eclosed larva climbs down to the ground and webs two blades of grass together at ground level. *Poa pratensis* L., *Koehleria cristata* (L.) Pers., *Andropogon gerardi* Vitman, *Stipa spartea* Trin., *Phleum pratense* L., and *Carex* sp. were all accepted by confined first instar larvae. Bunch grasses are preferred by *Hesperia* larvae, according to MacNeill (1964).

An older larva builds a silken tube lined with several blades of grass, enlarging it as the larva grows. Larvae seldom completely leave their tube, and feed mostly at night. The usual overwintering stage appears to be the fourth instar larva as determined by nearly a month's cessation of feeding in 8 of 10 larvae of this instar from one brood. Approximately 72 days, when the temperature reaches or exceeds 50°F, are required for the overwintering larva to develop to the adult stage.

The fully grown larva has a white patch on the venter of abdominal segments 7 & 8. This patch is comprised of a waxy hydrofuge substance produced by simple one-celled glands on the epidermis of the venter of the abdomen (Dethier, 1942). When the larva pupates, its turning action distributes this wax throughout and probably protects the pupa from excess moisture (MacNeill, 1964). High humidity is an important limiting factor on the survival of the skipper. A bacterial septicemia is known to kill *Hesperia* larvae held under humid conditions (MacNeill, 1964).

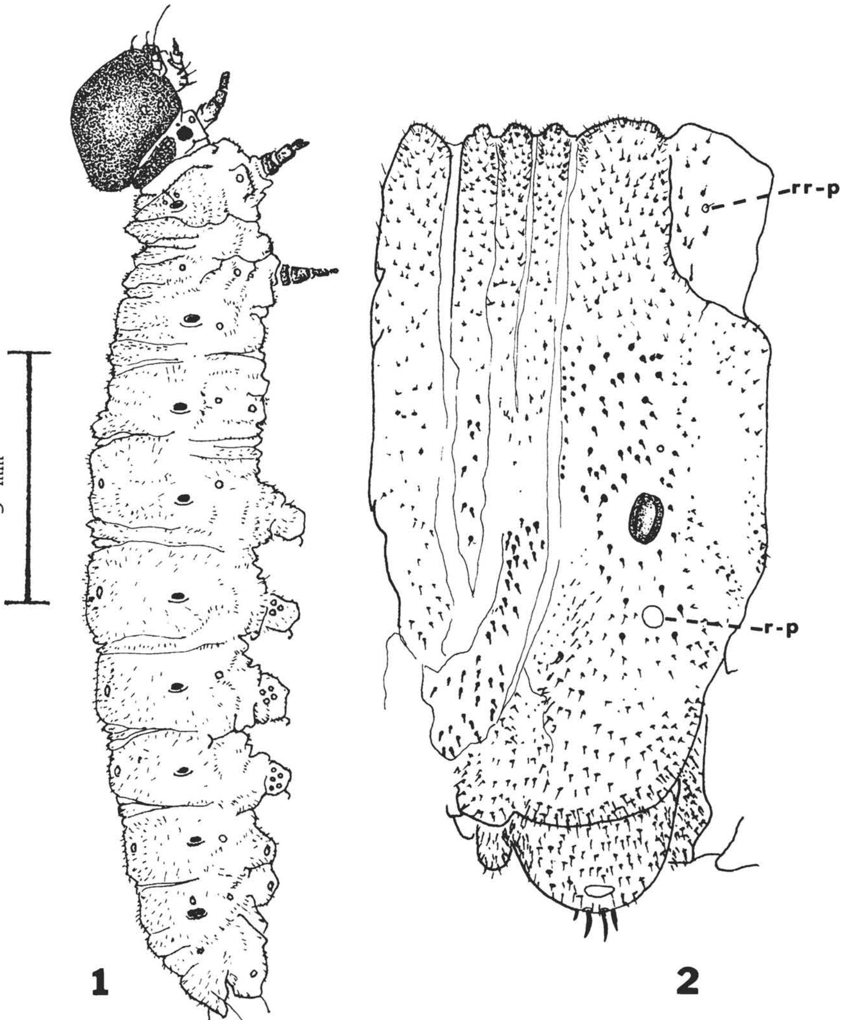
Dakota skipper larvae can be distinguished from all other described *Hesperia* larvae by the presence of pits on the ventral part of the head capsule. All other known *Hesperia* larvae have some portion of the lower face unpitted. The following description is based on ultimate instar larvae, but is supplemented, as indicated, with notes on earlier instars. I have used MacNeill's (1964) "ring-pores" for the peculiar plates of unknown function that appear on the integument. In addition, there are other ring-pore-like structures that are much smaller and lack the conspicuous inner plate of the ring-pore. I refer to these as rudimentary ring-pores. These are sometimes setigerous. Occasionally setae replace ring-pores on the thoracic segments of some larvae.

DESCRIPTION OF MATURE LARVA

General (Fig. 1): Head 2.80–3.00 mm wide. Total length 19.0–22.0 mm (N = 3). Abdominal prolegs present on third through sixth segments. *Crochets* multiordinal in a ring. *Anal comb* with 14–16 teeth. Head pitted throughout. Head and body with numerous short secondary setae, those on body blunt-tipped and probably glandular (Lindsey, 1923). Integument minutely granular (30 granules per 0.025 mm^2). Spiracle T1 0.33 mm high and spiracle A8 0.28 mm high. Primary abdominal setae absent. Sclerotized portion of thoracic legs spiny, claws notched at base.

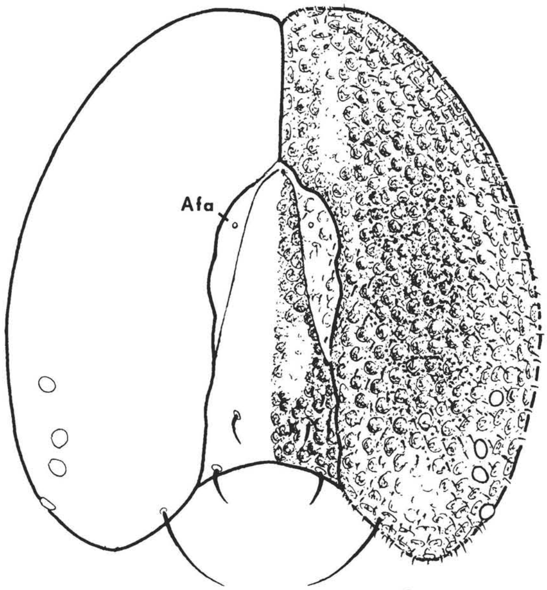
Coloration (living material): Head, prothoracic shield, thoracic legs, and spiracles black. Body light brown, flesh-colored. Venter of A7 and A8 covered with white wax in the ultimate instar larva.

Head (Fig. 3): Epicranial suture 0.90 mm long. Height of frons 1.52 mm. Adfrontal puncture (Afa) present as figured. Adfrontal seta apparently absent or not differentiated from numerous secondary setae. Lightly pigmented areas near vertex along epicranial



FIGS. 1 & 2. **1**, Sixth instar larvae of *Hesperia dacotae* from Felton, Clay Co., Minnesota. **2**, First abdominal segment of sixth instar larvae of *Hesperia dacotae*. rr-p, rudimentary ring-pore; r-p, ring-pore.

suture, between frontal and adfrontal sutures, on middle of frons, and on lower face as drawn. Ring-pores present at apex of dorsal pale area, one just above Oc-6, and a third directly above that, about midway up the head capsule. *Mouthparts:* Hypopharyngeal complex (Fig. 6): Spinneret much shorter than labial palpi, apex wedge-shaped and bare; proximal three-fourths of hypopharynx covered with fine spines; prementum with a notch in dorsal apex; basal segment of labial palpus with apical seta equal to twice the length of apical segment of palpus; apical segment with a short seta. Mandible



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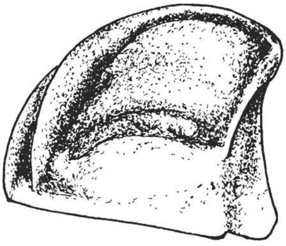

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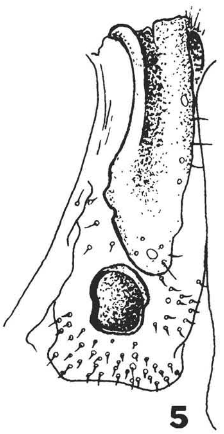

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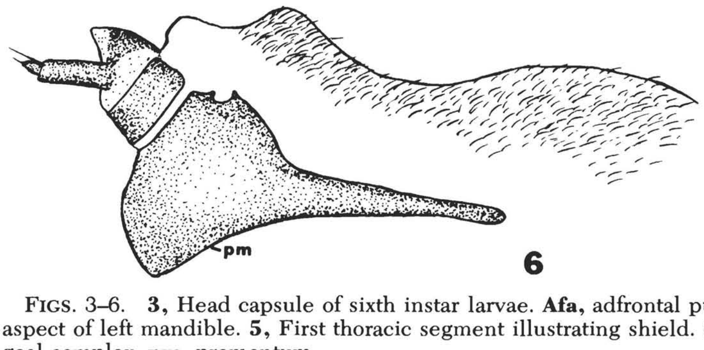

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FIGS. 3–6. **3,** Head capsule of sixth instar larvae. **Afa,** adfrontal puncture. **4,** Oral aspect of left mandible. **5,** First thoracic segment illustrating shield. **6,** Hypopharyngeal complex. **pm,** prementum.

(Fig. 4): Simple, lacking inner ridges or teeth, with a slight concavity near middle of oral face.

Thoracic segments: *Prothorax:* Cervical shield (Fig. 5) is subdivided in penultimate 6th instar larvae and in earlier instars, forming a second sclerite or subshield between the dorsal portion of the shield and the spiracle. Shield with a ring-pore along anterior margin of subdorsal region and at lateral apex. A primary seta, when present, replaces the lateral ring-pore of the shield. Shield with a transverse groove and a row of anterior

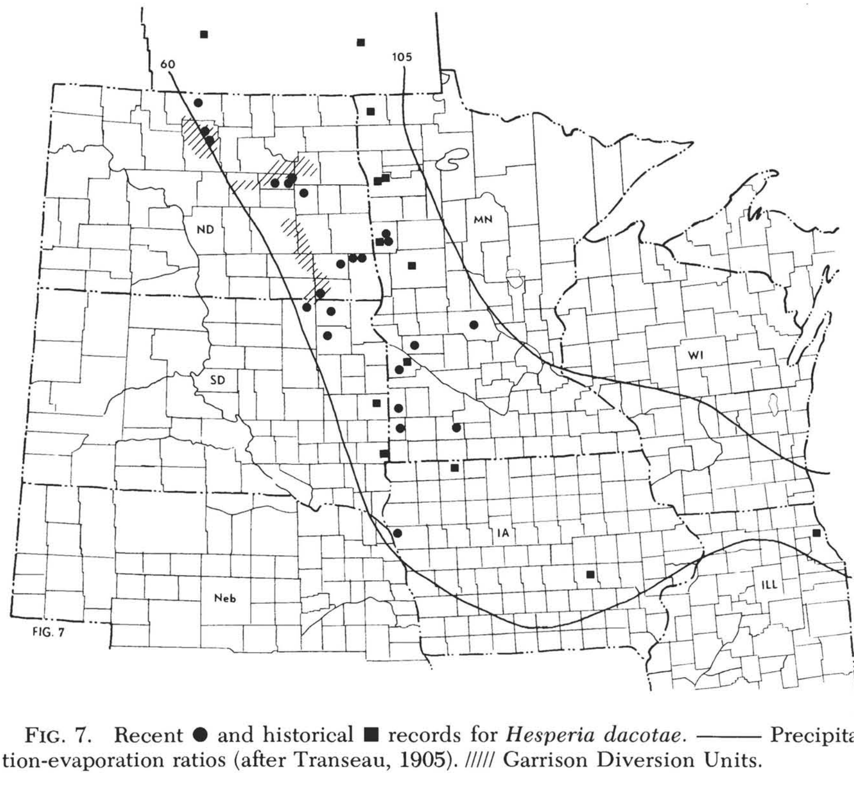

FIG. 7. Recent ● and historical ■ records for *Hesperia dacotae*. ——— Precipitation-evaporation ratios (after Transeau, 1905). ///// Garrison Diversion Units.

setae. Ring-pore present anterodorsal to coxal base. *Mesothorax* with simple, long, primary seta located midlaterally, just dorsal to line of abdominal spiracles. 2, 1, or 0 ring-pores present dorsal to this seta. Single sublateral ring-pore present. *Metathorax* with ring-pore present in line with mesothoracic seta and dorsal to line of abdominal spiracles. A second dorsal ring-pore present in penultimate instars, but absent in ultimate instar larvae. A single sublateral ring-pore present.

Abdominal segments (Fig. 2): *Ab-1&2:* Dorsal ring-pore present; lateral ring-pore present or absent, if present located posterior to line of spiracle; sublateral ring-pore, positioned below spiracle, present or absent, when present anterior or posterior to line of spiracle; ventral ring-pore present. Also a rudimentary ring-pore (sometimes setigerous) located dorsal to spiracle at about the distance of the diameter of the spiracle. Another rudimentary ring-pore present subdorsally on the anterior edge of the segment. *Ab-3:* Dorsal ring-pore present; lateral ring-pore present or absent; sublateral ring-pore present, anterior or posterior to vertical line of spiracle; ventral ring-pore absent; rudimentary ring-pore present anterodorsal to spiracle and subdorsal rudimentary ring-pore present in same position as that of Ab-1&2. *Ab-4:* Same as Ab-3 except 3–5 ring-pores present on each proleg. *Ab-5:* Same as Ab-3 except 3–7 ring-pores present on each proleg. *Ab-6:* Same as Ab-5. *Ab-7:* With dorsal ring-pore present; lateral ring-pore present or absent; sublateral and ventral ring-pores present. *Ab-8:* Lateral rudimentary ring-pore now anterior to and in line with the spiracle and less than one-half the diameter of the spiracle in distance from it. Subdorsal rudimentary ring-pore present and in same location as on Ab-3. Dorsal, lateral, and ventral ring-pore all present. *Ab-*

9: With dorsal, subdorsal, lateral and ventral ring-pores present or absent in any combination. *Ab-10:* With ventral ring-pore present. *Suranal plate:* Numerous pigment spots present on anterior margin of segment, varying in shape, number, and position.

Material examined: 3 sixth (ultimate) instar larvae, 1 sixth (penultimate) instar larva, and 3 fifth instar larvae, all reared from ova from a female collected at Felton prairie, lat. 47.03.44 long. 96.26.00 (T142N R45W S6), Clay Co., Minnesota. Larvae preserved 8 October 1979 and 15 September 1979. All larvae, P1♀, and 3 F1's are coded tlm 79-49. Duplicate specimens are deposited in the New York State Museum.

COURTSHIP

Females are initially encountered by males during routine territorial skirmishes. Any female flying within the visual range of the male is approached. The female promptly moves away a short distance and then alights. Inevitably, the male pursues the female to this point and lands below the female and climbs to a side-by-side position. This is done without the vibrating of the wings MacNeill (1964) observed in other species of *Hesperia*. The male curls the abdomen under and to the side and attempts to copulate with the female. If the female is receptive, she extends her ovipositor and they mate.

It is apparent in this species that the female has to be receptive to ensure mating. Males attempted to mate with females of their own species or with those of the sympatric *Polites themistocles* (Latreille). The female determined if the male was acceptable. This is in contradiction to what MacNeill (1964) reported for other species of *Hesperia*. I have observed intergeneric and even interfamilial mating attempts in other species of skippers, notably between a male *Epargyreus clarus* (Cramer) and a female *Megathymus streckeri texanus* B. & McD., and in my experience it is the female that determines the successful copulation.

Frequently the female rejects the first few advances of the male. The male eventually loses interest and leaves. Within a minute or two thereafter, the female will fly off and reach a new perch to bask, feed, or oviposit. If the male is unsuccessful in his first attempt to mate, he may rest alongside the female for a few minutes. Frequently he places both forelegs on the costa of the forewing of the female while resting. Female displacement behavior, during this time, consists of antennal grooming. Normally after a male loses interest in an unreceptive female, he flies to a nectar source and feeds (displacement activity) before resuming territorial perching. Total duration of a successful mating has not been recorded, although one pair was observed to mate and was still copulating 45 minutes later, but the pair had moved by the time the site was revisited after 60 minutes.

Territorial (used here to indicate intraspecific aggression) males frequently encounter one another leading to typically brief skirmishes, characterized by whirling, ascending flight. Both males involved often return to their original vantage point, usually a tall plant or an open area, and encounter each other repeatedly.

Submissive flight by males has been observed. This type of flight can be recognized by the lower pitch of the wings and the slower wing beat. Submissive males appear to be mistaken for females. On many occasions, three or four males have been observed pursuing a submissive male in a flight pattern reminiscent of males following females. The submissive male typically appeared to be larger than the aggressors. Several submissive males were captured and examined to eliminate the possibility of the presence of the similar and sometimes sympatric *Hesperia ottoe* Edwards. When the submissive male alights, the pursuing males quickly lose interest and return to their territorial sites.

ECOLOGY

I have observed the Felton prairie, Clay Co., Minnesota, for a number of years and have noticed a yearly shift of the Dakota skipper's main activity center (territoriality, oviposition, and mating) each year. Such movement may be an effect of contour (skipper usually seeks high vantage point), wind (skipper gathers on windward side of prairie), nectar sources, or edaphic conditions. Only one North Dakota site, the Karlsruhe prairie (Fig. 10), was large enough to support separate demes. A "walk-through"* count of 26 ♂♂ and 4 ♀♀ probably represents a mere tenth of one aggregation site, and as there were at least eight other widely separated aggregations noted on the Karlsruhe prairie, the overall population may run into the thousands. This may be the only population where deme interaction or deme size can be studied. All other known sites are so small that the population functions as a single deme.

Captured specimens of the Dakota skipper typically fly 150–200 feet when released and then settle down in the grasses. After a few minutes, the skipper begins to fly back to the vicinity of where it was disturbed, usually in 50 foot stages. Mark-recapture studies should work quite well with this species, but were not attempted because of time limitations. It is of interest that the skipper flew out of visual range of one observer. With two observers, one stationed directly downwind (the usual direction of escape flight) 150 feet, it was very easy to locate an individual on alighting. With only one observer, visual tracking was possible for less than 100 feet. This may be similar to the capabilities of a vertebrate predator, notably a bird, and might

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* All sightings during two parallel walks, 50 feet apart, through what appears to be the main concentration of activity.

FIG. 8. Nectar sources for *Hesperia dacotae* (given in order of preference).[1]

Ratibida columnifera (Nutt.)	[Asteraceae]
Erigeron strigosus Muhl.	[Asteraceae]
Echinacea angustifolia (DC.) Heller	[Asteraceae]
Gaillardia aristata Pursh	[Asteraceae]
Rudbeckia serotina Nutt.	[Asteraceae]
Campanula rotundifolia L.	[Campanulaceae]
Oenothera serrulata Nutt.	[Onagraceae]
UNACCEPTABLE NECTAR SOURCES[2]	
Asclepias ovalifolia Dec.	[Asclepiadaceae]
Apocynum sibiricum L.	[Apocynaceae]
Asclepias syriaca L.	[Asclepiadaceae]
Galium boreale L.	[Rubiaceae]
Lilium philadelphicum L.	[Liliaceae]
Petalostemum candidum Michx.	[Fabaceae]
Spiraea alba DurRoi	[Rosaceae]

[1] Based on number of sighting of feeding adults.
[2] Available at most sites, but not used by skipper.

explain why the skipper flies 150 feet and not 50 or 100 before alighting.

Year to year population peaks and declines have not been reported for the Dakota skipper. Sites I have visited repeatedly (since 1968) have a population that appears to be very stable. A decline appeared on the Felton prairie in 1975 when the prairie was hayed in June, but this was a result of emigration of the adults in search of nectar sources. Some mating and oviposition must have occurred on the first day or two from emergence to account for the quick rebound of the population (numbers were back to normal in 1977). A yearly June mowing would be highly detrimental. The Felton prairie is normally hayed in September, and then, not every year.

Interspecific competition does not appear to be the limiting factor of *H. dacotae* distribution. Other species commonly found on or near *H. dacotae* sites, and which have adults occurring at the same time, use dogbane and milkweed blossoms most frequently. These nectar sources are not used by *H. dacotae* (see Fig. 8). Only three attempted interspecific (and intergeneric) matings were observed and these were all between *Polites themistocles* females and *H. dacotae* males. In these instances, the male pursued the female until she rested and the male attempted to copulate, but the female was not receptive.

Actual predation on *H. dacotae* has been observed only from three groups: Ambush bugs (Hemiptera: Phymatidae; *Phymata* sp.), flower spiders (Aranaea: Thomisidae; *Misumena vatia* (Clerck)), and orb weavers (various Aranaea). The first two predators are cryptically colored to match flowers and are commonly found on *Ratibida colum-*

FIG. 9. Early season succession of prairie plants and butterflies.[1]

Date	Plant species[2]	Butterfly species—first noted and condition
16 June	*Oxalis violacea* L. *Lithospermum canescens* Michx. *Viola pedatifida* G. Don *Commandra pallida* A. DC.	*Chlosyne gorgone carlotta* (Reakirt)—worn ♂'s *Atrytonopsis hianna* (Scudder) —worn ♂'s, fresh ♀'s *Oeneis uhleri varuna* (Edw.) —worn ♂'s, fresh ♀'s
26 June	*Gaillardia aristata* Pursh* *Galium boreale* L.	*A. hianna*—worn ♀'s *O. u. varuna*—worn ♀'s *Lycaeides melissa* (Edw.) —fresh ♂'s *Coenonympha tullia benjamini* McD.—fresh adults
30 June	*Asclepias ovalifolia* Dec. *Onosmodium occidentale* Mackenz. *Psoralea esculenta* Pursh *Zigadenus elegans* Pursh *Erigeron strigosus* Muhl.* *Lilium philadelphicum* L.	*L. melissa*—fresh ♀'s *Polites themistocles* (Latr.) —fresh adults *A. hianna*—very worn
4 July	*Campanula rotundifolia* L.* *Oenothera serrulata* Nutt.*	*Polites mystic decotah* (Edw.) —fresh ♂'s *P. themistocles*—fresh adults
8 July[3]	*Petalostemum candidum* Michx. *Senecio plattensis* Nutt. *Ratibida columnifera* (Nutt.)*	*Hesperia dacotae* (Skinner) —fresh adults *Oarisma powesheik* (Parker) —fresh adults

[1] Succession study done in 1979 on the Felton prairie, Clay Co., Minnesota.
[2] The date the first opened blossoms were recorded; plants continued to bloom through skipper flight period in most cases.
[3] *Echinacea angustifolia* was still not in bloom although it occurs on the site and later in the season is an important nectar source.
* Flowers served as nectar sources for *Hesperia dacotae*.

nifera (Nutt.) and *Erigeron strigosus* Muhl., respectively. They are very effective predators of any nectar feeding insect. One of the chief nectar sources of *H. dacotae*, harebell (*Campanula rotundifolia* L.), is not utilized by flower spiders or ambush bugs. Orb weaver spiders appear to be successful only with old, worn individuals. Fresh active adults manage to quickly break from the webbing because they have an abundant supply of loose scales.

Many *H. dacotae* sites have numerous dragonflies, chiefly gomphids and libellulids. Despite many hours of observation, no dragonfly or bird predation was observed. Egg parasites have been reported for *Hesperia lindseyi* (Holland) (MacNeill, 1964) and a braconid larval parasite has been reported for *H. comma assiniboia* (Lyman) (McCabe & Post, 1977). The most important mortality factor appears to be the bacterial septicemia reported by MacNeill (1964).

FIG. 10. North Dakota Localities for *Hesperia dacotae*.

Site	Township-range-section	County	Approx. acreage
Karlsruhe	T154N R76W S20, 28–30	McHenry	1500
McLeod	T134N R53W S8	Ransom	100
Binford	T147N R60W S16	Griggs	150
Spring Creek	T149N R62W S22	Eddy	100
Oakes	T130N R58W S17, 18	Sargent	600
Towner	T157N R76W S17	McHenry	6
New Rockford	T149N R65W S29	Eddy	120
Hamar 1st	T150N R62W S23	Eddy	300
Hamar 2nd	T150N R62W S15	Eddy	40
Bottineau	T162N R76W S12	Bottineau	100
Colvin prairie	T149N R62W S32	Eddy	4
Kindred	T136N R51W S24	Richland	30
Walcott	T136N R51W S35	Richland	400

Alkaline prairies, required by the skipper, are poor soils and not desirable for cultivation. These soils are frequently used for pasturing cattle or for hay. Despite the existence of numerous such grazed prairies in North Dakota, only one grazed site, New Rockford (Fig. 10), had any *H. dacotae,* and this may have been the remains of a former population, as it was obvious that the prairie had only recently been converted to grazing. Through their movements, cattle may be physically destroying the larvae, although certain species of skippers, such as *H. comma assiniboia,* are able to tolerate grazing (McCabe & Post, 1977). The oligolectic habits of adult Dakota skippers, combined with the effect of grazing, may prohibit occupancy of both cattle and skipper. Tooth-leaved primrose, *Oenothera serrulata* Nutt., and harebell succumb rapidly before even light grazing pressure. Long-headed coneflower, *Ratibida columnifera* (Nutt.), and purple coneflower, *Echinacea angustifolia* (DC.) Heller, do a little better, but are eliminated by overgrazing. The very productive nectaries of milkweeds and dogbanes, generally avoided by grazers, are not utilized by the Dakota skipper. Other species of flowers will undoubtedly be used by the skipper as they become available in parts of the species' range.

Since Dakota skipper larvae are general feeders on grasses, one needs to look beyond a simple host requirement to determine why a particular prairie is acceptable habitat. Larvae make vertical, elongate, silk-lined tubes at the surface of the ground. Soil pH and humidity factors may be of importance to larval survival. Most Dakota skipper sites have standing water in the surrounding ditches, indicating probable periodic high humid conditions at ground level, despite the gravelly subsurface soils. Soil pH has proved to be an important factor in terms of survival in some skipper species. Freeman

(1964) found that one megathymid skipper had a pH tolerance range of less than 0.2. The white ladyslipper, *Cypripedium candidum* Willd., frequently found on *H. dacotae* sites, requires a soil pH of 7.2–7.8 (Sheviak, 1974). Prairie fringed orchid, *Habenaria leucophaea* (Nutt.) Gray, and wild lily, *Lilium philadelphicum* L., also calciphiles, are typically found on these prairies. Camas, also known as "alkali grass," *Zigadenus elegans* Pursh, another calciphile, was found everywhere the Dakota skipper occurred and the converse was true with rare exception. At no stage is the skipper dependent on camas, and it is just coincidence that both species have similar habitat requirements. The occurrence of the skipper and camas together outside of North Dakota has not been studied. Camas is much easier to detect than the skipper, and, as an added feature, camas blossoms' development and senescence closely approximates that of the flight period of the adult skipper. Camas, at least in North Dakota, is an extremely reliable indicator of Dakota skipper habitat.

Grassland used for hay is normally mowed before *Stipa* grasses produce seed or else after seed drop. *Stipa* grass seeds are barbed and will stick in an animal and subsequently benefit from active animal transport. Cattle can be injured when the ripe seeds penetrate the mouth, hence these grasses must be harvested early or late in the season if they are to be used for cattle feed. The seeds are formed almost the same time the skipper begins to fly. Pre-seed harvesting destroys nectar sources for the adult skipper and forces the skipper to emigrate in search of nectar.

The ideal maintenance of Dakota skipper prairies consists of late-season mowing, a practice that can easily be arranged with local farmers on publicly owned lands. Late-season haying provides the best cover for ground-nesting birds and is also the preferred treatment for prairie orchids. Curtis (1946) studied the white ladyslipper which had been continually losing ground on the University of Wisconsin arboretum. With either early spring (April in Wisconsin) or late-season mowing, Curtis was able to double orchid production. In the historical past, periodic grazing by buffalo and occasional prairie fires may have maintained the habitat, but it is likely that the adult skipper was forced to seek new locations under these circumstances. As much habitat was suitable during this period, a migration and recolonization effort was feasible. Under present extensive agricultural practices, suitable habitats have been reduced to widely separated "islands," virtually eliminating any successful recolonization attempts.

Burning is probably not a cure-all for the skipper. A June through early July burn would destroy the eggs which are on exposed vegetation. Diapausing fourth instar larvae may be destroyed if ground level heat reaches a critical point. Susceptibility of adults or larvae to burns is not known. A burn at night would very likely destroy the adults and a slow back-burn may destroy any larval stage, not to mention the loss of nectar sources and depletion of nitrogen.

Prairies that are "preserved" from all activities show rapid plant succession and result in an undesirable growth of woody shrubs. I witnessed this transition on a prairie south of Buffalo State Park, Clay Co., Minnesota. Ownership of the prairie changed and it was no longer cut for hay. Public opinion prevented burning at the time and willows and horsetails began to dominate many sections. Finally, a controlled burn was performed, but several species, including *Hesperia comma,* have not been taken there since. I do not know which practice, lack of haying or the burn, eliminated the skipper.

A late-season mowing that is timed to the best advantage of prairie flowers, ground-nesting birds, and the Dakota skipper is needed. A very late (October) mowing is optimal. Any attempt at a burn should be done with the knowledge of the location of the previous season's main oviposition sites and these sites should be sheltered from the burn. I am aware of a Dakota skipper prairie (Hook & Bullet Refuge, lat. 46.48.21, long. 96.23.38, Clay Co., Minnesota) that has been maintained by mowing for more than 50 years.

HISTORICAL PERSPECTIVE AND DISTRIBUTION

The Dakota skipper was described in 1911 by H. Skinner from a series of adults collected at Volga, South Dakota by Dr. Truman and from Grinnell, Iowa, presumably collected by Parker. Holland (1931) figured a paratype. Lindsey et al. (1931) gave additional records for Sioux City, Iowa. Lindsey (1942) gave records for Miniota, Manitoba; Lake West Okoboji, Iowa, and remembered seeing specimens from the Chicago area. Irwin & Downey (1973) reported three specimens of *H. dacotae* in the Carnegie Museum that were labeled Illinois. I visited the Carnegie Museum, where I was able to examine the holotype of *H. dacotae* and also dissected a specimen labeled "Ridgeland, Ill." (now a part of Chicago) which proved to be a *H. dacotae.* It was last recorded in Illinois in 1888. Macy & Shepard (1941) give the additional localities of Winnipeg, Manitoba; Gentilly, Polk Co., Madison, Lac Que Parle Co., and Kittson Co., Minnesota. Nordin (1967) gave records for Brown Co., South Dakota. Hooper (1973) mentions Brandon, Manitoba and McCabe & Post (1977) give records for Bottineau, Richland, and Ransom Counties, North Dakota. Nordin (pers. comm.) adds Day and Marshall Counties, South Dakota and Downey has taken it in Woodbury Co., Iowa (pers. comm., R. L. Huber). Huber (pers. comm.) has taken it in Pipestone and Cottonwood

Counties, Minnesota and both Huber and Dana have it from Lincoln Co., Minnesota. Dana and Muggle have recorded it from Stearns Co., Minnesota (pers. comm., R. Dana). Numerous people have recorded it from the Felton prairie, Clay Co., Minnesota.

There appears to be a correlation between precipitation-evaporation ratios and skipper distribution (Fig. 7). This is supported by present known distribution and biological inferences that are based on mortality factors and habitat requirements. Only a small portion of the overall area circumscribed by the precipitation-evaporation ratios of 60 to 105 (Transeau, 1905) is suitable for colonization by the skipper. Within this narrow belt the species needs to have proper edaphic conditions and suitable nectar sources. Lake Michigan possibly served as a physical barrier to the eastern extension of the species' range. Northern limits have not been established because of the lack of records from Manitoba.

McCabe & Post (1977) reported ". . . *dacotae* is associated with the shorelines of glacial lakes . . . Agassiz and Souris in our area." Even with additional records from the present study, this still appears to be the case in North Dakota. The east-central North Dakota records are on the shores of Glacial Devil's Lake (see Lemke et al., 1965, for map of glacial lakes) and the southernmost North Dakota record and northeastern South Dakota records are on the shores of Glacial Lake Dakota. More southerly records, however, show no correlation to glacial lakes with the exception of the single Illinois record (Glacial Lake Chicago).

Glacial lake shorelines are frequently alkaline. The skipper's apparent pH requirements may mean that shores are good habitats. In addition, the gravelly shores are poor for most agricultural purposes and are spared from cultivation. After the retreat of the Wisconsinan glaciers, the species may have pushed northward, and presently occurs only on shorelines because of the loss of suitable habitat elsewhere. Climatic factors, particularly precipitation-evaporation ratios, and edaphic factors in conjunction with present agricultural practice, may account for the distribution. Conversely, the skipper may have been a "shore species" during the time of the glacial lakes, and has failed to expand its range since the lakes were drained (7500–12,500 years before present for Glacial Lake Agassiz (Flint, 1971)).

ACKNOWLEDGEMENTS

This survey has been supported by the Reclamation Bureau (now the Water and Power Resources Service) and the New York State Museum. I thank Ms. Martha Carlisle and Mr. Don Treasure, Water and Power Resources Service, and Mr. Robert Nofsinger, Fish and Wildlife, for assistance in the field. Dr. George Wallace and Dr. C. J. McCoy allowed me access to the Carnegie Museum collection. I am especially indebted to Mr. Ron Huber for encouragement and counsel early in my study of skippers and much correspondence over the years on *Hesperia dacotae* and other species. I thank Carol Teale for the illustrations.

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