

OCCURRENCE AND SEASONAL INCIDENCE OF MOSQUITOES ON INDIAN RESERVATIONS IN IOWA, NEBRASKA AND SOUTH DAKOTA DURING 1983¹

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ABSTRACT. A mosquito surveillance program designed to prevent future human cases of Western equine encephalitis or Saint Louis encephalitis was established in 1983 on Indian reservations under the jurisdiction of the Aberdeen Area Indian Health Service in Iowa, Nebraska and South Dakota. Standard New Jersey light traps were operated on all reservations throughout the summer season while CDC miniature and encephalitis virus surveillance traps were employed for shorter periods of time on 4 reservations. *Aedes vexans* was the most abundant species except on the Pine Ridge, Rosebud, Winnebago and Yankton Sioux reservations in which *Culex tarsalis* predominated and for the Sac-n-Fox where *Aedes trivittatus* occurred with the greatest frequency.

INTRODUCTION

Mosquito surveillance activities that are routinely conducted by health authorities in many northcentral states, namely Minnesota (Sjogren 1980) Nebraska, and North Dakota did not exist before 1983 in South Dakota. The potential for mosquito-borne disease nevertheless always existed in this state and mosquito populations resurged in 1982 and 1983 when above average rainfall supplied necessary conditions to increase mosquito population densities in South Dakota as well as in the neighboring state of Minnesota (Washburn 1985). An outbreak resulting in 18 human cases of Western equine encephalitis (WEE) and 11 cases of Saint Louis encephalitis (SLE) in South Dakota in 1975 was believed to have resulted from similar environmental circumstances. Intensive summer precipitation inundated waterways and low lying areas in several states and a widespread epidemic in equines and humans resulted. The mosquito surveillance program was therefore organized in 1983 to prevent the recurrence of an outbreak and thereby protect human residents on reservations under the jurisdiction of the Aberdeen Area Indian Health Service in Iowa, Nebraska and South Dakota. This program was designed to complement activities already underway by the Health Department in North Dakota (Ken Tardiff, personal communication) that were protecting residents, including those on reservations in that state.

Considerable information exists on potential mosquito production sites on the flood plains associated with the rise and fall of the water level on Lewis and Clark Lake. This man-made

impoundment was formed by the construction of the Gavins Point Dam on the Missouri River that separates Nebraska and South Dakota (U.S. Public Health Service 1956, 1958; Edman 1964, Hayes et al. 1978). Even though Edman (1964) discussed the effects of this impoundment on mosquitoes inhabiting the neighboring Santee reservation in northeastern Nebraska, there is little published information available on mosquito distribution or abundance on Sioux reservations to the north or the west of this area.

MATERIALS AND METHODS

Adult mosquitoes were collected from June 11 through September 19, 1983 using standard New Jersey light traps (NJLT) (Hausherr's Machine Works, Toms River, NJ) equipped with a 25 watt inside frosted bulb as an attractant. Unit area sanitarians on each reservation serviced the traps weekly.

All traps were placed in wooded areas protected from the wind and suspended 1.5–1.8 m above the ground away from the proximity of competing lights. In Nebraska the NJLT was placed in a oak woodland on the Santee Sioux Indian Reservation on a flood plain near the Lewis and Clark Reservoir. Figure 1 shows the location of trap sites. Traps on the Omaha and Winnebago reservations in Nebraska were in cottonwood timber within tall grass prairie. On the Cheyenne River, Crow Creek, Lower Brule, Pine Ridge, Rosebud and Yankton Sioux reservations in South Dakota, traps were placed in cottonwood timber surrounded by short grass prairie. Traps at both Flandreau and Sisseton were in tall grass prairie but the Flandreau location was in elm/ash/cottonwood woodland. The collecting container consisted of standard quart mason jars charged with pieces of 2.5 cm long no-pest-strip (dichlorvos insecticide) embedded in plaster-of-paris. Weekly mosquito samples collected from each reservation were sent in mailing tubes to South Dakota State

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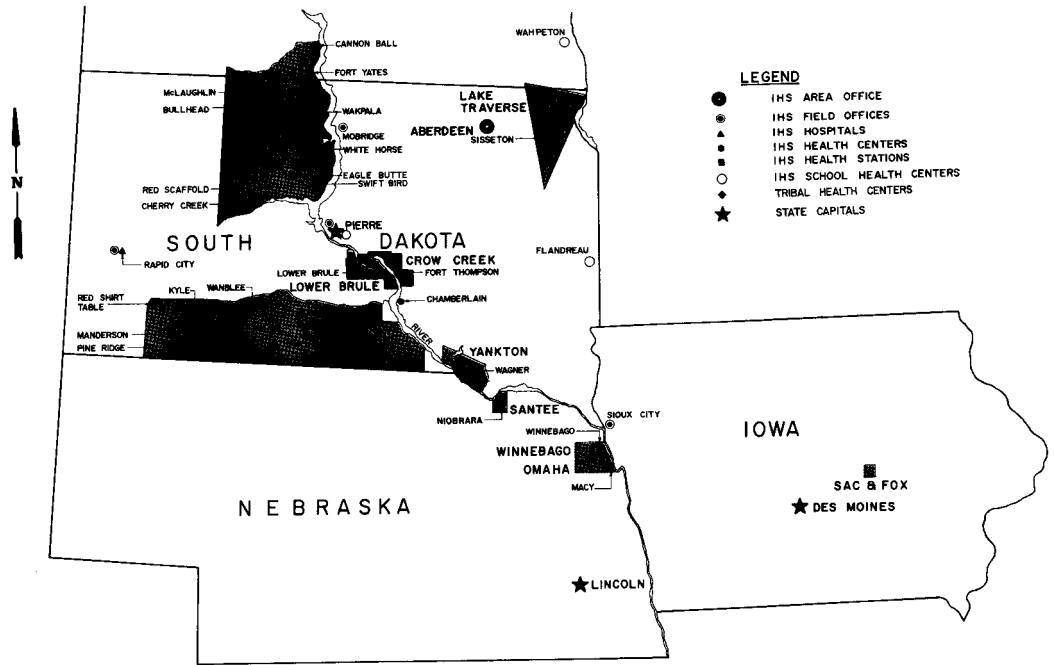


Fig. 1. Location of reservations in Iowa, Nebraska and South Dakota where light trap collections were made. Figure courtesy of the Aberdeen Indian Health Service.

University where they were sorted to species and females identified (Darsie and Ward 1981, Gerhardt 1966). Encephalitis virus surveillance traps (EVS) producing carbon dioxide as an attractant (Bioquip Products Co., Santa Monica, CA), were operated on the Sac-n-Fox reservation in Iowa, the Winnebago in Nebraska, and

the Rosebud and Yankton Sioux reservations in South Dakota. CDC miniature light traps, also using dry ice, were placed on 3 of the same reservations as the EVS traps. The CDC trap was also used on the Pine Ridge reservation in South Dakota (Table 1). Live material of *Culex tarsalis* Coquillett collected by R. Ballinger was

Table 1. Comparison of the New Jersey, encephalitis vector surveillance (EVS) CO₂ and the CDC miniature light traps for the collection of *Aedes vexans* and *Culex vexans* females during the summer season of 1983 from 5 Indian reservations in the Aberdeen Area Indian Health Service.

Reservation	New Jersey trap			EVS CO ₂ trap			CDC miniature light trap		
	<i>Ae. vexans</i>	<i>Cx. tarsalis</i>	Total	<i>Ae. vexans</i>	<i>Cx. tarsalis</i>	Total	<i>Ae. vexans</i>	<i>Cx. tarsalis</i>	Total
Pine Ridge (Ogala, Pine Ridge, Wanblee, Wak Pamm Lake)	561	387	2,238 ¹				2,510	2,776	6,005
Rosebud (Rosebud-Mission-Spring Creek and Antelope)	5	121	269	27	3,743	4,147 ²	2	40	42
Sac-n-Fox ³	3	0	36	272	2	3,070	66	1	317
Winnebago	159	273	619	0	49	54			
Yankton				14	429	444	11	42	69
Totals	778	755	3,162	313	4,223	7,715	2,589	2,859	6,433

¹ Composed of *Cq. perturbans*, *Ae. campestris*, *Ae. dorsalis*, *Ae. nigromaculis* and *Cu. inornata*.

² 377 *Coquillettidia perturbans* were caught by the EVS trap.

³ The EVS trap caught 2,752 female *Aedes trivittatus* and the CDC a total of 204 female *Ae. trivittatus* on this reservation during the same period.

submitted to the CDC Public Health Service Laboratory in Fort Collins, Colorado for attempted isolation of encephalitis viruses.

Larval collections were made on the Rosebud and Pine Ridge reservations with a 0.47 liter dipper on an extendable aluminum handle to determine the extent of breeding sources for *Cx. tarsalis*.

RESULTS

TRAPPING DATA. The EVS and CDC miniature light traps were operated on single night intervals during this period. The NJLT fitted with a clock timer was operated daily from 2100 to 0800 hr on each reservation (except Crow Creek and Lower Brule) from June 11 through September 19. A total of 28,825 female mosquitoes were collected by all 3 trap types in 1983. The NJLT caught 14,673 females alone; however, on reservations where more than one type of trap was employed, the NJLT (Table 1) attracted smaller numbers (3,329) than either the EVS trap (7,719) or the CDC miniature light trap (6,433). The largest numbers of mosquitoes were collected on the Pine Ridge reservation (8,410) in Jackson and Shannon counties with fewer numbers sampled in decreasing order of abundance from the Cheyenne River (4,672) in Dewey and Ziebach counties; the Rosebud (4,462 in Todd County; Sisseton (3,521) in Roberts County; the Sac-n-Fox (3,433) in central Iowa and the least from Flandreau (1,088) in Moody County, SD. Less than 1,000 specimens per reservation were taken on the remaining sites: Winnebago (673) in Thurston County, NE; Yankton Sioux (513) in

Charles Mix County, SD; Omaha (502) in Thurston County, NE; the Santee (540) in Knox County, NE; Crow Creek (306) in Buffalo County, SD; and the Lower Brule (203) in Lyman County, SD.

DISCUSSION

Aedes vexans Meigen was the most abundant species collected with the NJLT on all reservations (Table 2). *Culex tarsalis* was second in abundance on most reservations except for Pine Ridge, Rosebud, Winnebago and Yankton Sioux, where *Cx. tarsalis* was reported as the most abundant mosquito. *Culex tarsalis* was the fifth and sixth most abundant species, respectively, on the Santee and Sac-n-Fox reservations.

Rainfall in the amount of 10.1 and 5.3 cm/month in May and June, respectively, on the Cheyenne River Reservation at Dupree, Ziebach County, is believed to have resulted in the peak number of 1,144 *Ae. vexans* collected by the NJLT during the week of July 4-11. Otherwise, the population of *Ae. vexans* declined throughout the remainder of the season. At Timber Lake, Dewey County, on the same reservation a peak occurred during the week of August 1-8 with 880 *Ae. vexans* and 992 from August 8 to 12, then the population declined.

At Sisseton in Roberts County where rainfall averages 55.3 cm/year (U.S. Climatological Summary No. 19), 2,557 *Ae. vexans* were collected during the week of July 11-17 where rainfall amounts for June are ordinarily the highest for the summer season. In 1983 however, 5.6 cm fell in June but August received

Table 2. *Aedes vexans* and *Culex tarsalis* mosquito collections utilizing the New Jersey light trap from 7 Indian reservations in Nebraska and South Dakota during the summer of 1983.

Indian reservation	<i>Aedes vexans</i>		<i>Culex tarsalis</i>		Other species		Total mosquitoes	
	No.	(%) ¹	No.	(%) ¹	No.	(%) ¹	No.	(%) ¹
Cheyenne River, SD	4,571	(40.3)	310	(2.7)	342 ²	(3.0)	5,223	(46.0)
Crow Creek, SD	245	(2.2)	33	(0.3)	28 ³	(0.2)	306	(2.7)
Flandreau, SD	832	(7.3)	128	(1.1)	81 ⁴	(0.8)	1,041	(9.2)
Lower Brule, SD	143	(1.3)	33	(0.3)	27 ⁵	(0.2)	203	(1.8)
Omaha, NB	160	(1.4)	80	(0.7)	262 ⁶	(2.3)	502	(4.4)
Santee, NB	196	(1.7)	8	(0.1)	136 ⁷	(1.2)	340	(3.0)
Sisseton, SD	3,331	(29.4)	163	(1.4)	235 ⁸	(2.1)	3,729	(32.9)
Total	9,478	(83.6)	755	(6.6)	1,111	(9.8)	11,344	(100.0)

¹ The percentage (%) of *Aedes vexans*, *Culex tarsalis* and other species is in relation to the total mosquito fauna on 7 reservations in 1985.

² Composed of *Aedes campestris*, *Ae. dorsalis*, *Ae. nigromaculis*, *Ae. sollicitans*, *Cq. perturbans* and *Cs. inornata*.

³ *Ae. campestris*, *Ae. dorsalis* and *Ae. nigromaculis*.

⁴ *Ae. dorsalis*, *Ae. nigromaculis*, *Ae. sollicitans*, *Cs. inornata* and *Cq. perturbans*.

⁵ *Aedes* sp.

⁶ *An. punctipennis*, *Ae. triseriatus*, *Ae. trivittatus*, *Cx. salinarius* and *Cs. inornata*.

⁷ *An. walkeri*, *Ae. trivittatus* and *Cx. salinarius*.

⁸ *An. barberi* and *Ae. dorsalis*.

12.1 cm, which was 7.6 cm above normal. On the Pine Ridge reservation in southwestern South Dakota, rainfall averages 41.4 cm/year (U.S. Climatological Summary No. 11) and the average accumulation for May, June and July is 8.0, 8.1 and 4.8 cm/month, respectively, which is generally lighter than at Sisseton and counties on the eastern edge of the state. Accumulations of 12.2, 8.4, 10.4 and 4.0 cm/month recorded for May, June, July and August, respectively on the Pine Ridge in 1983, were 10.2 cm higher than normal resulting in 245 *Ae. vexans* collected during the first week of August and the high for the season. Peak numbers of *Ae. vexans* were also collected using the CDC light trap (2,510) (Table 1) from August 22 to 26.

The maximum number of *Cx. tarsalis* collected by the NJLT from August 2 to 8 on the Pine Ridge is also consistent with 2,776 mosquitoes (Table 1) taken with the CDC miniature light trap from August 22 to 26. At Cheyenne River, *Cx. tarsalis* reached a peak of 109 mosquitoes during the week of July 4–11 when rainfall in May was 4.2 cm above normal.

Aedes vexans was the most important pest mosquito in South Dakota and *Culex tarsalis* the most frequently encountered member of its genus here (Gerhardt 1966). Results of the present study indicate that these species are still of major importance.

COMMENTS ON OTHER SPECIES. Gerhardt (1966) reported *Aedes campestris* Dyar and Knab from Beadle, Brule, Codington and Perkins counties in South Dakota. In the present study *Ae. campestris* was found only on the Cheyenne (37) and Pine Ridge (4) reservations.

Aedes canadensis (Theobald) has been recorded in South Dakota from Bon Homme, Brookings and Spink counties (Gerhardt 1966). We collected it only from the Pine Ridge (76) in Shannon County. *Aedes dorsalis* (Meigen) is considered to be widespread in Nebraska as well as in South Dakota, but populations are generally higher on the short grass prairie which comprises the western two-thirds of these states. This species was found on 5 reservations in South Dakota: the Cheyenne (276), Crow Creek (6) Flandreau (9), Pine Ridge (410), and Sisseton (60). This species was also collected from the Winnebago in Nebraska (3), and the Sac-n-Fox (1) reservations in Iowa. *Aedes flavescens* (Müller) was found only on the Pine Ridge (37) and *Aedes hendersoni* Cockerell only from the Flandreau (8) and Pine Ridge (40) reservations in this study. *Aedes nigromaculis* (Ludlow) which occurs throughout Nebraska (Lunt and Rapp 1981) and in South Dakota (Gerhardt 1966), is believed to reach maximum abundance in the short grass prairie portions of the state which are largely west of the Missouri River. This spe-

cies occurred on 5 reservations: the Cheyenne River (52), the Crow Creek (20), Flandreau (22), the Pine Ridge (348) and the Rosebud (1) in South Dakota; and the Winnebago (2) in Nebraska.

Conclusive evidence is not available that *Aedes triseriatus* (Say) occurs in South Dakota. Although Gerhardt (1966) earlier listed *Ae. triseriatus* as occurring in South Dakota, the mosquitoes he identified were probably *Ae. hendersoni*. Samples of eggs that E. R. Easton collected with ovitraps on the eastern side of the state in 1978 near Brookings, were subsequently identified as *Ae. hendersoni* rather than *Ae. triseriatus* (George B. Craig, Jr., personal communication). In this study *Ae. triseriatus* was found only on the Sac-n-Fox reservation (34) in Central Iowa. Even though Lunt and Peters (1976) reported *Ae. triseriatus* as occurring along the Platte River in central Nebraska, they did not report it along the Missouri River between Nebraska and South Dakota.

Anopheles quadrimaculatus Say occurs mainly in the eastern portions of South Dakota, however, in 1983 it was collected only on the Sac-n-Fox (1) in Iowa. *Anopheles barberi* Coquillett was reported only at Flandreau (1); *Anopheles punctipennis* (Say) from the Omaha (18), Winnebago reservations (21) in Nebraska, and the Sac-n-Fox (19) in Iowa. *Anopheles walkeri* Theobald was collected on the Pine Ridge (38) in South Dakota, and the Santee (44) in Nebraska where it is considered to be very common at times. During the first week of August 1985 3,320 *An. walkeri* were collected on the Santee using the NJLT.

Coquillettidia perturbans (Walker) occurs throughout Nebraska (Lunt and Rapp 1981). In South Dakota it has been reported from Beadle, Bennett, Brookings, Brule, Butte, Spink and Walworth counties (Gerhardt 1966). *Coquillettidia perturbans* was the most abundant mosquito present on the Pine Ridge Reservation (870) and was second in abundance to *Cx. tarsalis* on the Rosebud (460).

Culex salinarius Coquillett has been reported throughout Nebraska (Lunt and Rapp 1981), and in South Dakota has been reported from Beadle, Bon Homme, Brookings, Brule, Butte, Charles Mix, Corson, Davison, Fall River, Hughes, Spink and Yankton counties (Gerhardt 1966). *Culex salinarius*, in the present study, was collected on the Yankton (8) in South Dakota; from the Omaha (56), Santee (16) and Winnebago (65) reservations in Nebraska; and the Sac-n-Fox (31) in Iowa.

Culiseta inornata (Williston) occurs throughout Nebraska (Lunt and Rapp 1981) and South Dakota (Gerhardt 1966). It is more abundant in the spring and fall and uncommon in the mid-

dle of summer. This species was collected on the Cheyenne River (37 during the month of September), Pine Ridge (44 in the middle of August), and Rosebud (4) in South Dakota; and from the Omaha (56) and Winnebago (4) reservations in Nebraska.

One specimen of *Orthopodomyia signifera* (Coquillett) was reported on the Sac-n-Fox. This species may reach its northern limit in South Dakota having previously been recorded only from Bon Homme and Yankton counties (Edman 1962). Darsie and Anderson (1985) discuss an older record in North Dakota indicating its uncommon occurrence to the north of this area.

Psorophora ferox (Humboldt) has been collected from Beadle, Bon Homme, Kingsbury, Butte and Yankton counties in South Dakota (Gerhardt 1966). In the present study it was collected from only Flandreau (51) in Moody county.

Psorophora signipennis (Coquillett) has been collected throughout Nebraska (Lunt and Rapp 1981) but is sparsely distributed in South Dakota and reported in Bon Homme, Brookings, Charles Mix, Harding, Fall River, Hughes, Union and Yankton counties. Our single site was at the Cheyenne River in Ziebach County (11).

LARVAL COLLECTIONS. On August 8, *Cx. tarsalis* larvae (2–5/dip) were collected from a large unpolluted ground pool on the Pine Ridge Indian reservation. The site was located in a ravine protected by an overstory of cottonwood trees and shrubs at the west end of Wanblee Community, Jackson County. *Culex tarsalis* was also noted on June 30 in an open field drainage site near the White River, 1.6 km north of Oglala in Shannon County. On the Rosebud reservation *Cx. tarsalis* larvae (3–5/dip) were collected from a grassy ground pool near Mission, Todd County, on July 9.

VIRUS ISOLATION EFFORTS. According to current recommendations in North Dakota (State Dept. of Health, Bismark; Ken Tardiff, personal communication), *Cx. tarsalis* is considered to be of potential public health significance when 20–25 females are captured/trap/night in NJLTs or when 150 females are caught during a period of one week from a single trap. If this level occurs for 2 weeks or more at any site, attempts are made to isolate virus from freshly collected mosquitoes. This activity is routinely carried out in North Dakota and since 1983 efforts have been made to coordinate our surveillance activities with that state. Even though numbers of *Cx. tarsalis* on the Rosebud reservation failed to exceed this threshold during the weeks ending July 29 or August 1 (28 and 78 mosquitoes, respectively) with the NJLT, larger

numbers were collected (Table 1) with the EVS trap.

A total of 1,040 live *Cx. tarsalis* in ten-100 count vials and one 40 count vial from 3 communities on the Rosebud Reservation were collected and sorted on August 10, 1983 by R. Ballinger and sent to Chester G. Moore of the USPHS Laboratory at Fort Collins, Colorado. Seven vials were from the Spring Creek area, 3 from Rosebud community, and 1 from the Antelope community. No isolations however, of WEE or SLE, resulted from these samples.

One human case of WEE was reported in South Dakota during 1983 but the 16 equine cases reported (Arboviral Encephalitides U.S. 1983, Morbidity/Mortality Weekly Report, 32 (43), Nov. 4, 1983) were greater in number than those reported from the surrounding states, indicating the presence of viral activity. We believe that when rainfall is normal or above normal, many areas in South Dakota will continue to be important as a potential source for mosquito production.

Even though we are aware of only one published account of a WEE virus isolation from *Cx. tarsalis* in eastcentral South Dakota (Larson et al. 1971), the almost yearly report of cases in equines (Annual Rept. of S.D. Livestock Sanitary Bd., 1984–1985) indicates a continual presence of viral activity in this state.

References Cited

- Darsie, R. F. Jr. and A. W. Anderson. 1985. A revised list of the mosquitoes of North Dakota including new additions to the fauna. *J. Am. Mosq. Control Assoc.* 1:76–79.
- Darsie, R. F., Jr. and R. A. Ward. 1981. Identification and geographical distribution of the mosquitoes of North America, north of Mexico. *Mosq. Syst. Suppl.* 1:1–313.
- Edman, J. D. 1962. New mosquito records for South Dakota. *J. Kansas Entomol. Soc.* 35:430–432.
- Edman, J. D. 1964. Control of *Culex tarsalis* (Coquillett) and *Aedes vexans* (Meigen) on Lewis and Clark Lake (Gavins Point Reservoir) by water level management. *Mosq. News* 24:173–185.
- Gerhardt, R. W. 1966. South Dakota mosquitoes and their control. *S.D. Agric. Exp. Stn. Bull.* 531. 80 pp.
- Hayes, R. O., J. M. Stewart, C. J., Mitchell, L. J., Ogden and F. C. Harmston. 1978. Lewis and Clark Lake mosquito control recommendations. *J. Environ. Engineering Div. ASCE.* 104:701–716.
- Larson, D. R., J. E. Rowe, R. O. Hayes, P. Holden and G. C. Parikh. 1971. Preliminary report on arbovirus isolations from South Dakota mosquitoes collected during the summer of 1969. *Mosq. News* 31:157–159.
- Lunt, S. K. and G. E. Peters. 1976. Distribution and ecology of tree-hole mosquitoes along the Missouri and Platte Rivers in Iowa, Nebraska, Colorado and Wyoming. *Mosq. News* 36:80–84.

- Lunt, S. R. and W. F. Rapp, Jr. 1981. An annotated list of the mosquitoes of Nebraska. *Mosq. News* 41:701-706.
- Sjogren, R. D. 1980. Control of *Aedes vexans* in the Midwest: Current status and future needs. *Mosq. News* 40:341-346.
- United States Public Health Service. 1956. Field study of mosquito problems on Lewis and Clark Lake (Gavins Point Reservoir) near Springfield, South Dakota, August 9-10, 1956. C.D.C., Atlanta, Georgia.
- United States Public Health Service. 1958. A follow-up study on mosquito problems associated with the Gavins Point and Fort Randall Reservoirs, S. Dakota, August 18-20, 1958. C.D.C., Atlanta, Georgia.
- Washburn, J. W. 1985. Mosquitoes as vectors of disease in Minnesota. *J. Minn. Acad. Sci.* 50:12-15.

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