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MOSQUITOES OF GRAND TETON NATIONAL PARK, TETON COUNTY, WYOMING, USA

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ABSTRACT. An inventory of the mosquitoes of Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway was conducted during 1998 and 2000. Twenty-five culicid species belonging to 3 genera and 5 subgenera were recorded. This is the 1st substantive effort to record the mosquito fauna of this national park since its establishment in 1929. Collection of specimens of *Ochlerotatus communis* and *Ochlerotatus nevadensis* from the same larval site supports the species status of *Oc. nevadensis.*

KEY WORDS Culicidae, mosquito, Grand Teton, Wyoming, *Ochlerotatus nevadensis,* Yellowstone, Rockefeller, national park

INTRODUCTION

Since 1922, Yellowstone National Park, immediately north of Grand Teton National Park (GRTE) and John D. Rockefeller, Jr. Memorial Parkway (JODR), has been the location of extensive culicid collections by eminent entomologists, including Dyar, Rees, Harmston, Nielsen, and Blackmore (Dyar 1922, 1923; Rees and Harmston 1948; Nielsen and Blackmore 1996). However, the area that today comprises GRTE and JODR has been collected from only incidentally since 1934. Culicid collections within the current boundaries of GRTE and JODR were recorded only from the since-relocated town of Moran in 1934, 1945, and 1949 (Rees and Harmston 1948, Gerhardt 1951), Jenny Lake in 1947 (Rees and Harmston 1948), and Jackson Lake in 1950 (Gerhardt 1951).

The greater Yellowstone ecosystem is the largest essentially intact natural area in the contiguous United States. This 5.7 million-ha ecosystem, centered around northwestern Wyoming, includes Yellowstone National Park, GRTE, JODR, National Elk Refuge, Bridger-Teton National Forest (NF), Beaverhead NF, Custer NF, Gallatin NF, Shoshone NF, Caribou NF, Targhee NF, and other federal, state, and private lands.

In 1929, GRTE was established as a 38,850-ha national park encompassing the Teton Mountain range in northwestern Wyoming. This impressive north–south range, approximately 72 km in length, includes at least 8 peaks higher than 3,600 m. Dominated by the Grand Teton at 4,197 m, the Teton range includes 10 active glaciers, and stands precipitously above the valley floor to the east, known as Jackson Hole. A large portion of Jackson Hole, with an average elevation of 2,073 m, was added to GRTE in 1950, increasing the total area of GRTE to more than 125,412 ha. In 1972, the 9.7-km gap between the northern entrance to GRTE and the southern entrance to Yellowstone National Park was established as JODR. This 9,622-ha area, administered by GRTE, is dominated by the Snake River. The current total area of GRTE and JODR is approximately 135,034 ha. The park, located 6 km north of the town of Jackson, WY, is open year-round and receives approximately 4,000,000 visitors annually. Jackson is the county seat of Teton County, of which 96.2% is under federal control, primarily by the National Park Service (NPS) and the U.S. Forest Service (NPS 1991, 1997).

MATERIALS AND METHODS

From June 2 to September 13, 1998, and from May 15 to 17, 2000, the author conducted an inventory of the mosquitoes of GRTE and JODR. Principal efforts included the collection of culicid larvae and the aspiration of adult mosquitoes feeding on humans throughout GRTE and JODR, especially in those areas occupied by recreational tourists. The U.S. Code of Federal Regulations (36 CFR 2.2) prohibits the collection of wildlife, including insects, within the U.S. National Park System, except where such activity either is determined by the park superintendent to be consistent with public safety and enjoyment and sound resource management principles, or is mandated by federal statutory law. As of February 1999, §2(a)(2)(iii), Executive Order 13112 (invasive species), requires each federal agency to monitor populations of invasive species accurately and reliably (The White House 1999). Potentially invasive species cannot be monitored without baseline knowledge of the native species of the region. Therefore, under the provisions of 36 CFR 2.5, specimen collection permits (NPS permits GRTE 98-19 and GRTE 00-12) were issued to the author for the purpose of conducting an inventory of the mosquito fauna of GRTE and JODR.

Locations of collection sites were recorded as universal transverse Mercator coordinates, to the nearest 10 m, with a global positioning satellite receiver. Place names used to refer to collection sites were taken from current maps of the park (U.S. Geological Survey 1968, NPS 1997).

Larval and pupal collections routinely were made with a standard 350-ml dipper. However, a

Table 1. List of culicid species collected from Grand Teton National Park and John D. Rockefeller, Jr. Memorial Parkway in 1998 and 2000.

Aedes (Aedes) cinereus Meigen
Ae. (Aedimorphus) vexans (Meigen)
Culiseta (Culicella) morsitans (Theobald)
Cs. (Culiseta) alaskaensis (Ludlow)
Cs. (Cs.) impatiens (Walker)
Cs. (Cs.) inornata (Williston)
Ochlerotatus (Ochlerotatus) canadensis canadensis (Theobald)
Oc. (Oc.) cataphylla (Dyar)
Oc. (Oc.) communis (De Geer)
Oc. (Oc.) diantaeus (Howard, Dyar, and Knab)
Oc. (Oc.) dorsalis (Meigen)
Oc. (Oc.) euedes (Howard, Dyar, and Knab)
Oc. (Oc.) excrucians (Walker)
Oc. (Oc.) fitchii (Felt and Young)
Oc. (Oc.) flavescens (Müller)
Oc. (Oc.) hexodontus (Dyar)
Oc. (Oc.) implicatus (Vockeroth)
Oc. (Oc.) increpitus (Dyar)
Oc. (Oc.) intrudens (Dyar)
Oc. (Oc.) mercurator (Dyar)
Oc. (Oc.) nevadensis (Chapman and Barr)
Oc. (Oc.) pullatus (Coquillett)
Oc. (Oc.) punctor (Kirby)
Oc. (Oc.) spencerii idahoensis (Theobald)
Oc. (Oc.) ventrovittis (Dyar)

few collections necessitated the use of a small siphon because of restricted access. Adult mosquitoes routinely were collected with a mechanical aspirator (Hausherr's Machine Works, Toms River, NJ) when landing to bite the exposed arms and lower legs of the author during a 10-min period. A few adult specimens were collected as they rested in dwellings and nondwelling structures. On a few occasions, adult mosquitoes were collected with Centers for Disease Control–style light traps (incandescent white light, model 1012, and fluorescent ultraviolet light, model 1212, John W. Hock Co., Gainesville, FL), at a height of 1.2 m, without additional attractant. Larvae were slide-mounted with CMC-10 media (Masters Chemical Co., Bensenville, IL) or reared to adults for identification. Pupae were reared to adults. All adults were pin-mounted on paper points. The taxonomic references of Darsie and Ward (1981) and Ward and Darsie (1982) were used to identify 4th-stage larvae and adult females.

RESULTS

Twenty-five culicid species belonging to 3 genera and 5 subgenera were recorded (Table 1). Selected collection data are listed in Table 2 and Fig. 1.

All species collected were expected according to the geographical distributions of Darsie and Ward (1981) or subsequent reports (Nielsen 1982, Nielsen and Blackmore 1996). All mosquito species collected in this effort were considered to be native species. Selected larval and adult mosquito specimens have been deposited in the entomological collection of Grand Teton National Park, Moose, WY. With the permission of the NPS, the author retained additional specimens for research and educational purposes.

DISCUSSION

Of 52 larval collection sites visited from June 2 to 26, 1998, and May 15 to 17, 2000, 40 sites (76.9%) were positive for culicid larvae. No mosquito larvae were collected at an additional 40 collection sites, visited from June 26 to September 12, 1998.

Among 190 adult (human-biting) collection sites sampled from June 2 to September 13, 1998, 93 sites (49.0%) were positive for adults. The peak period of adult biting behavior was from mid-June to late July, although bites were recorded throughout the entire period of June 2 to September 13, 1998.

Both *Ochlerotatus communis* (De Geer) and *Ochlerotatus nevadensis* (Chapman and Barr) were collected as larval cohabitants at 1 collection site near Jackson Lake Dam. Schutz and Eldridge (1993), by means of polyacrylamide gel electrophoresis, reported that *Oc. nevadensis* seemed to represent a single species in the Communis Complex. However, no evidence was found of *Oc. nevadensis* and *Oc. communis* s.s. as cohabitants in their effort. The Teton collection of *Oc. communis* and *Oc. nevadensis* specimens from the same larval site supports the findings of Schutz and Eldridge (1993) and reinforces the status of *Oc. nevadensis* as a separate species.

Nine culicid species have been reported from nearby areas, but have not yet been collected within GRTE and JODR. Three species, *Ochlerotatus campestris* (Dyar and Knab), *Anopheles earlei* Vargas, and *Culex tarsalis* Coquillett, have been reported previously from Yellowstone National Park to the north and the nonfederal portions of Teton County to the east and south of GRTE. Four species, *Ochlerotatus impiger* (Walker), *Ochlerotatus pionips* (Dyar), *Anopheles punctipennis* (Say), and *Culiseta incidens* (Thomson), have been collected in Yellowstone, but have never been reported in Teton County outside Yellowstone. Two species, *Ochlerotatus hendersoni* (Cockerell) and *Ochlerotatus trivittatus* (Coquillett), have not been collected in Yellowstone, but have been collected rarely as adults in light traps in nonfederal areas of Teton County east and south of GRTE (Rees and Harmston 1948; Nielsen and Blackmore 1996; T. Brooks, Teton County Weed and Pest District, personal communication).

Six species of mosquito were expected by the geographical distribution maps provided by Darsie and Ward (1981), but have not yet been collected in GRTE, JODR, Yellowstone National Park, or the

Table 2. Selected data for culicid species collected from Grand Teton National Park and John D. Rockefeller, Jr. Memorial Parkway in 1998 and 2000.

	Larvae			Adults (human-biting)			
Species[1]	Dates	Positive/ total locations[2]	Elevation range (m)	Dates	Positive/ total locations[2]	Elevation range (m)	Percentage[3]
Ae. cinereus	June 2–26, 1998	0/24	NA[4]	July 12–Aug. 15, 1998	3/38	2,087–2,202	2.6
Ae. vexans	June 2–24, 1998 May 15–17, 2000	14/38	1,822–2,097	July 21–Sept. 12, 1998	18/48	2,003–2,393	14.6
Cs. alaskaensis	June 2–26, 1998	0/24	NA	July 5, 1998	1/5	2,759	0.1
Cs. impatiens	June 2–26, 1998	0/24	NA	June 2–July 5, 1998	2/35	1,997–2,759	0.9
Cs. inornata	June 14, 1998	1/4	1,990	June 2–July 5, 1998	5/35	1,940–2,759	0.9
Cs. morsitans	June 8, 1998	1/4	2,054	June 2–Sept. 13, 1998	0/93	NA	0
Oc. c. canadensis	June 9–21, 1998 May 15–17, 2000	3/24	1,940–2,099	June 2–Sept. 13, 1998	0/93	NA	0
Oc. cataphylla	June 26, 1998 May 15–17, 2000	5/18	1,433–2,171	July 5, 1998	2/2	2,252–2,809	0.3
Oc. communis	June 7–14, 1998 May 15–17, 2000	5/29	2,037–2,167	June 8–Aug. 23, 1998	58/85	1,871–3,016	54.4
Oc. diantaeus	June 26, 1998 May 15–17, 2000	2/18	1,343–2,171	July 3–29, 1998	10/40	1,955–2,809	2.4
Oc. dorsalis	May 15–17, 2000	1/16	2,099	June 2–Sept. 13, 1998	0/93	NA	0
Oc. euedes	June 14, 1998	1/4	2,167	June 2–Sept. 13, 1998	0/93	NA	0
Oc. excrucians	June 3–26, 1998 May 15–17, 2000	8/39	1,343–2,162	July 3–Aug. 22, 1998	5/59	2,055–2,313	0.6
Oc. fitchii	June 6–14, 1998 May 15–17, 2000	12/34	1,343–2,167	July 3–Aug. 15, 1998	7/51	2,105–2,202	1.4
Oc. flavescens	June 9–14, 1998	2/7	1,940–2,167	June 2–Sept. 13, 1998	0/93	NA	0
Oc. hexodontus	June 2, 1998 May 15–17, 2000	11/17	1,433–2,122	June 2–Sept. 13, 1998	0/93	NA	0
Oc. implicatus	June 9, 1998 May 15–17, 2000	5/18	1,433–2,076	June 8–12, 1998	2/10	1,969–2,135	0.3
Oc. increpitus	June 6–24, 1998	4/20	2,002–2,097	July 3–Aug. 22, 1998	8/59	2,004–2,202	4.0
Oc. intrudens	June 2–26, 1998 May 15-17, 2000	6/40	2,034–2,167	July 3–Aug. 22, 1998	21/59	2,004–2,880	6.6
Oc. mercurator	June 9, 1998	1/2	1,970	June 2–Sept. 13, 1998	0/93	NA	0
Oc. nevadensis	June 6–10, 1998	2/14	2,113–2,037	June 2–Sept. 13, 1998	0/93	NA	0
Oc. pullatus	June 7–14, 1998 May 15–17, 2000	4/29	1,940–2,172	Aug. 16, 1998	1/6	2,758	0.1
Oc. punctor	June 2, 1998	1/1	2,034	July 3–Aug. 15, 1998	5/51	2,055–2,759	1.3
Oc. s. idahoensis	June 2–26, 1998	0/24	NA	June 8–July 29, 1998	3/64	2,075–2,338	0.4
Oc. ventrovittis	June 3–9, 1998	2/14	1,970–2,068	June 6–Sept. 12, 1998	28/92	1,969–3,016	9.2

[1] *Ae., Aedes; Cs., Culiseta; Oc., Ochlerotatus.*

[2] The number of larval (or adult) collection sites from which the species was collected compared to the total number of larval (or adult) collection sites in which culicids were collected during the time period listed.

[3] The contribution of the species to the total number of culicid specimens taken in human-biting collections from June 2 to September 13, 1998.

[4] NA, not applicable.

	Ae. cinereus	*Ae. vexans*	*Cs. alaskaensis*	*Cs. impatiens*	*Cs. inornata*	*Cs. morsitans*	*Oc. c. canadensis*	*Oc. cataphylla*	*Oc. communis*	*Oc. diantaeus*	*Oc. dorsalis*	*Oc. euedes*	*Oc. excrucians*	*Oc. fitchii*	*Oc. flavescens*	*Oc. hexodontus*	*Oc. implicatus*	*Oc. increpitus*	*Oc. intrudens*	*Oc. mercurator*	*Oc. nevadensis*	*Oc. pullatus*	*Oc. punctor*	*Oc. s. idahoensis*	*Oc. ventrovittis*
Ae. cinereus	0																								
Ae. vexans		3					2	1					5	3	1	4	1	2	3			1	1		1
Cs. alaskaensis			0																						
Cs. impatiens				0																					
Cs. inornata					1																				
Cs. morsitans						1																			
Oc. c. canadensis		2					0		1	1	1				1			1				1			
Oc. cataphylla		1						0		1			2	1		4	2		1						
Oc. communis							1		0	1	1	1		3	1				1		1	1			1
Oc. diantaeus							1	1	1	0	1		1	1					1						
Oc. dorsalis							1		1	1	0														
Oc. euedes									1			0		1	1				1						
Oc. excrucians		5						2		1			1	4		3	1	1	1						1
Oc. fitchii		3						1	3	1		1	4	2	1	2	4		2	1		1			1
Oc. flavescens		1					1		1			1		1	0				1			1			
Oc. hexodontus		4						4					3	2		3	2		1			1	1		
Oc. implicatus		1						2					1	4		2	0		1	1					1
Oc. increpitus		2					1						1					2							
Oc. intrudens		3						1	1	1		1	1	2	1	1	1		1				1		1
Oc. mercurator														1			1			0					1
Oc. nevadensis									1												0				
Oc. pullatus		1					1		1					1	1	1						0			
Oc. punctor		1														1			1				0		
Oc. s. idahoensis																								0	
Oc. ventrovittis		1							1				1	1			1		1	1					0

Fig. 1. Larval culicid cohabitants from Grand Teton National Park and John D. Rockefeller, Jr. Memorial Parkway in 1998 and 2000. Black numbers in white boxes indicate the number of larval collection sites where species coincided. White numbers in black boxes indicate the number of larval collection sites in which the species had no culicid cohabitants.

nonfederal portions of Teton County. These species, including *Ochlerotatus melanimon* (Dyar), *Ochlerotatus sticticus* (Meigen), *Anopheles freeborni* Aitken, *Culex pipiens* Linnaeus, *Culex restuans* Theobald, and *Culex territans* Walker, actually may be present throughout the area, but have simply evaded capture to date.

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