2014. Proceedings of the Indiana Academy of Science 123(1):49–56

OCCURRENCE AND SUSPECTED FUNCTION OF PREMATERNITY COLONIES OF EASTERN PIPISTRELLES, *PERIMYOTIS SUBFLAVUS*, IN INDIANA

John O. Whitaker, Jr.[1] and **Brianne L. Walters**: Center for Bat Research, Outreach, and Conservation, Department of Biology, Indiana State University, Terre Haute, IN 47809, USA

Jacques Pierre Veilleux: Department of Biology, Franklin Pierce University, Rindge, NH 03461, USA

Richard O. Davis: Clifty Falls State Park, Madison, IN 47250, USA

ABSTRACT. During summer, some pregnant female Eastern Pipistrelles form colonies in buildings but most typically roost in clusters of live or dead leaves in trees. We provide evidence that some that ultimately roost in leaf clusters form temporary colonies in or on buildings in early spring, prior to moving to the leaf clusters where they give birth. We call these prematernity colonies, and define them as those formed for a short time following hibernation and before the bats move to their maternity roosts. Prematernity colonies form from late April to early May and individuals relocate to leaf clusters from late May to early June. The bats showed strong fidelity to prematernity roosts, returning annually. Time of occupancy during any one year averaged 26 days. Nine bats were radio-tracked during the transition from building to tree roosts and were found to use several different trees. Bats showed interannual fidelity to building roosts. Buildings may help colonies re-form after individuals migrate from their hibernacula. Also, they could provide a warmer or more stable microclimate for pregnant females.

Keywords: Bats, bat roosts, Eastern Pipistrelles, prematernity colonies

INTRODUCTION

Bats regularly roost in anthropogenic structures, with commensal roosting behavior in buildings becoming nearly obligate in some species. For example, *Myotis lucifugus* (LeConte) (Little Brown Myotis) and *Eptesicus fuscus* (Beauvois) (Big Brown Bat) often form maternity colonies in human structures (Whitaker & Gummer 1992, 1993). Presumably these species formed maternity colonies in trees prior to the arrival of Europeans. Benefits of buildings may include protection from the elements (including a warmer and more stable microclimate), as well as relative permanence as most buildings likely remain available for relatively long periods as compared to tree roosts. Of 401 bat roosts located in buildings in Indiana between 1987 and 1992 (Whitaker & Gummer 1993), 330 were of Big Brown Bats, 58 of Little Brown Myotis, 12 of Eastern Pipistrelles (*Perimyotis subflavus*) (F. Cuvier), and one of the Evening Bat (*Nycticeius humeralis* Rafinesque). This indicates that relatively few Eastern Pipistrelles use buildings as roost sites in Indiana. (Note—We have retained the common name Eastern Pipistrelle for this species because this name has long been in use and because there is already a tricolored bat, *Glyphonycteris sylvestris* (Phyllostomidae), of Central and South America (see Whitaker et al. 2011).

Many species of hibernating bats leave hibernacula in spring and move to their summer roost areas where females form maternity colonies and give birth. Little is known about their behavior during the period following hibernation and prior to forming maternity colonies. However, the females of many temperate bat species return to the same maternity roost structure each year, whether it be a tree (Indiana Myotis, *Myotis sodalis* Miller & Allen; Northern Myotis, *M. septentrionalis* Trouessart), a building (*Myotis lucifugus*, *Eptesicus fuscus*), or a cave or mine (Gray Bat, *Myotis*

[1] *Corresponding author:* John O. Whitaker, Jr., 812-237-2383 (phone), 812-237-3378 (fax), john.whitaker@indstate.edu.

grisescens A. H. Howell) (Whitaker & Mumford 2009).

Eastern Pipistrelles roost primarily in clusters of dead leaves in trees in Indiana (Veilleux et al. 2003) and Arkansas (Perry & Thill 2007), although in Nova Scotia, Poissant et al. (2010) found them roosting exclusively in *Usnea trichodea* Ach., a lichen which typically occurs in conifers. Annual fidelity to summer (maternity) roost areas was reported for foliage roosting Eastern Pipistrelles by Veilleux & Veilleux (2004a). However, they exhibit fidelity to broad roost areas, rather than to a single roost (leaf cluster) site, since specific foliage roosts are ephemeral and may not be available across years (Veilleux & Veilleux 2004b).

Whitaker (1998) studied the life history patterns of six colonies of Eastern Pipistrelles in building roosts in Indiana. Five of the six served as maternity roosts in which bats had their young and remained for the majority of the maternity season. One roost (Jackson Roost in 1990) was abandoned before the maternity season and therefore, no young were produced at the site. Eight bats in the Jackson Roost first arrived on 21 May, and the colony increased to a maximum of 13 bats. Most bats left that colony by 23 June. We now suspect that this was a prematernity colony as described in this paper. We have since identified three additional prematernity roosts which were used only during spring, before bats moved to the more typical foliage roosts. The goal of this paper is to describe the behavior patterns we observed in these three roosts. The use of a prematernity roost has not been previously described. Specifically our goals were to determine the size of the colonies, when they form, when they relocate, whether the bats move to foliage roosts when they leave, and if they show fidelity to the prematernity roost site.

METHODS

We studied three Eastern Pipistrelle prematernity colonies in Indiana: the Parshall-Layton colony, the Lowry colony, and the Clifty Falls colony. The first two colonies contained only pregnant females, as determined by palpation. The Parshall-Layton colony was identified in 1995 in Seelyville, Vigo County. Individuals roosted along the rafters of an open porch/breezeway about 12 m high. The bats clustered in the open and usually roosted in the same specific location. The site was used by bats during each successive year until 2003 when nearly all the nearby trees (roost trees?) were removed and the bats apparently relocated elsewhere. The Lowry colony was observed in 2002, 2003, and 2008. The bats roosted in a small shed near a house in Clinton, Vermillion County. Bats had been present at the roost in early spring for at least three years prior to 2002 and had returned to the roost during each year through 2008. Most bats were usually in one main cluster. The Clifty Falls colony was discovered in 1999 at Clifty Falls State Park, Jefferson County. Individuals roosted under the eaves of the main building of the park nature center and have returned to the site during each year of the study.

The owners/occupants of each of the buildings watched for the bats each year and contacted us when they arrived. The authors conducted exit counts each evening until the bats relocated and residents continued to observe the roosts and informed us if the bats returned. The small size of the three colonies and the tendency to roost in well lit, accessible areas, allowed data collection regarding arrival and departure dates as well as direct counts of individuals during observation periods. Some bats from two of the colonies were banded to determine if they returned to the same roost during successive years.

To investigate where bats roosted after leaving the Lowry roost sites, 0.35 or 0.45 g radio transmitters (Model LB-2N or LB-2, Holohil Inc., Ontario, Canada or Model LTM, Titley Electronics, New Ballina, Australia) were used. A small amount of fur was trimmed from between the scapula using scissors, and the transmitter was affixed using a non-toxic, surgical adhesive (Skin-Bond, Smith+Nephew, Largo, Florida). A single individual from the Parshall-Layton colony was radio-tagged twice in 1998 and once in 2001, and nine individuals from the Lowry colony were radio-tagged in 2008. Transmitters averaged 6% of body mass. Using a VHF radio-receiver (Model TRX2000S, Wildlife Materials, Carbondale, Illinois) and a 3-element Yagi antenna, bats were tracked to their roosts on each day, until the transmitter battery failed or the transmitter fell from the bat.

RESULTS

The bats in the Parshall-Layton and Lowry colonies were all pregnant females, as indicated

Table 1.—Results of bat banding at the Parshall/Layton roost, Vigo County, Indiana: 1998–2003. N = new bat for year; R = return from previous year; BNR = bands not read; UBB= unbanded bats; NBNR = new banded bats, but no returns.

Band number	1998	1999	2000	2001	2002	2003
Y202	N	R	R	R	R	R
W1006		N		R		R
W1085		N		R		R
W1086		N		R		R
W1088		N		R		
BNR			5		4	1
UBB	6					
NBNR		2	2	4	4	4
N =	7	7	8	9	9	9

by palpating the abdomen. Bats in the Clifty Falls colony were not handled but were assumed to be pregnant females since their behavior was similar to that of the Parshall-Layton and Lowry colonies.

We monitored the Parshall-Layton colony (Table 1) for six years (1998 through 2003), although limited data were collected in 2002. Dates of first arrival ranged from 26 April to 18 May, with colony size ranging from 7 to 9 individuals (Fig. 1). Dispersal from the prematernity roost, presumably to tree roosts, ranged from 23 May to 12 June (no data for 2002 or 2003). Some individuals were absent for portions of each year; residence time (number of days between first arrival and latest occupancy) ranged from 20 to 32 days ($\bar{x}$ = 26 days). A single female from the Parshall-Layton roost (Y202) was banded on the forearm in 1998 with a plastic split-ring band (Table 1). An additional six bats were banded in 1999. Three of these individuals were recaptured at the prematernity roost in 2001 and 2003. Bat Y202 returned to the building roost for all six years of observation. This bat was radio-tracked in 1998 to a white oak tree (*Quercus alba* L.) located 600 m from the Parshall-Layton roost where it remained from

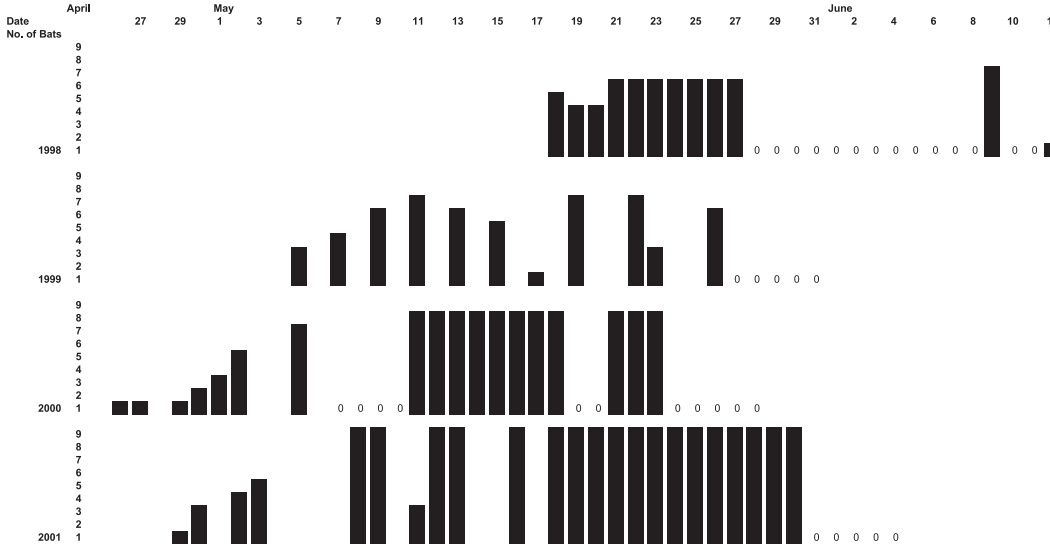

Figure 1.—Numbers of Eastern Pipistrelles on various dates at Parshall-Layton colony, Vigo County, Indiana: 1998–2001. A zero indicates no bats were present; a blank indicates no observation was made. This figure does not include the years 2002 and 2003 since complete population assessments were not made. Residents of the properties notified us when the bats arrived each year, and also watched to be sure the bats did not return after our last observations.

Table 2.—Results of bat banding at the Lowry roost, Clinton, Vermillion County, Indiana: 2002, 2003, and 2008. N = new bat for year, R = return from previous year.

Band number	2002	2003	2008
4001	N	R	
4002	N	R	R
4003	N		
4004	N	R	R
4005	N		
4006	N		
4007	N	R	R
4008	N	R	
4009	N		
4010	N		R
4012	N	R	
4013	N		
4014	N	R	
4201		N	R
4202–4206*		N (5)	
6151			N
6152			N
6155			N
6192			N
6200			N
N =	13	13	10

* These 5 bats were banded in 2003, but were not seen in 2008.

10 through 13 June. Emergence counts were conducted during this time and two to four bats were observed emerging from this tree. On each of those days, one of the emerging bats was the radio-tagged Eastern Pipistrelle Y202. This bat was radio-tagged again on 30 May 2001 and subsequently located on 31 May and 1 June, roosting in two different trees, each approximately 200 m from the white oak used in 1998. On 2 June, 2001, bat Y202 roosted in the white oak used in 1998.

At the Lowry roost, data were collected during three years (2002, 2003, and 2008; Table 2). Dates of first arrival ranged from 27 April to 27 May. Colony size ranged from 10 to 13 individuals. Dates of latest occupancy ranged from 25 May to 8 June. As in the Parshall-Layton colony, some individuals were absent for portions of 2003. Residence time ranged from five to 29 days ($\bar{x}$ = 16 days). A total of 13 individuals, appearing to comprise the entire colony, was banded in 2002 with seven returning in 2003 and five in 2008 (Table 2). On 27 May 2008, 11 females were present at the Lowry roost, including five banded in 2002 and 2003. Nine were radio-tagged (Table 3, Figs. 2, 3). One bat (6155) disappeared, and the remaining 8 were tracked for up to 6 days ($\bar{x}$ = 3.8, 1-6). Bat 6200 roosted for 2 days in a cluster of leaves in the top of a fallen red oak (*Quercus rubra* L.), then roosted in four different trees. Bat 6192 roosted two days in the shed, then one day in a tree, and bat 4201 two days in the shed, then four days in different trees. Bat 4010 roosted one day in the shed, and one day in a cluster of leaves in a small oak tree. Bat 4004 roosted in three separate days in three different oak trees. Another bat (4002) remained in the shed one night then roosted in a tree, whereas bat 4007 roosted two days in a cluster of leaves in an oak tree. Thus, the bats moved into clusters of leaves in trees not far from the prematernity shed.

Of these bats individuals were in the shed seven times, and all entered leaf clusters in trees on 20 occasions ($\bar{x}$ = 2.5, 1–6) within 200 m of the shed. The bats roosted in a total of 13 trees including red and white oak (*Quercus*), hickory (*Carya*), elm (*Ulmus*), maple (*Acer*), and one tulip poplar (*Liriodendron tulipifera* L.).

The bats have formed prematernity colonies at Clifty Falls since at least 1999 (Table 4), but data were collected only during three years (2001, 2002, and 2003). Other than one bat that appeared 28 April, dates of first arrival ranged between 1 and 20 May. Dates of latest occupancy were between 24 May and 8 June. Residence time ranged from 19 to 24 days ($\bar{x}$ = 22.5 days). These bats were not handled, not banded, and no radio-telemetry was conducted.

Dates of first arrival at the building roosts generally occurred between late April and late May and mean group size during this period was 11 bats (range 9–13). Residence time in prematernity roosts ranged from five to 32 days. Prematernity colonies generally relocated to tree roosts from late May to early June, with the latest observed relocation date of 25 June. We suspect that females were nearing parturition when they moved from the buildings to roost in foliage. The timing of these observations was similar to those for these bats in buildings as reported by Whitaker (1998).

DISCUSSION

The data indicate that during summer, some female Eastern Pipistrelles living in woods have

Table 3.—Eastern Pipistrelles (*Perimyotis subflavus*) radio-tagged 27 May 2008 from the Lowry colony in Clinton, Vermillion County, Indiana. X = not found that day; bat left, or radio lost. NV. = bat not actually viewed. Distance and direction from shed. Unid. = unidentified. Numbers in parentheses on the table correspond to tree numbers. It was not always possible to determine in exactly which tree a bat was roosting.

Bat	28 May 08	29 May 08	30 May 08	31 May 08	1 June 08	2 June 08
6200	NV. 150 m NE cluster of leaves in top of fallen white oak tree (10)	Same as on 28 May	NV. 90 m N bitternut hickory or red or white oak tree (7)	NV. 35 m NE in red or white oak tree (2)	NV. 195 m N in bitternut hickory tree (15)	NV. 100 m N in red or white oak tree (8)
6192	Shed	Shed	NV. 155 m N in bitternut hickory or white oak tree with A04201 (14)	Radio on ground near 30 May roost site		
4201	Shed	Shed	NV. 155 m N in bitternut hickory or white oak tree with A06192 (14)	NV. 145 m N in tulip poplar (13)	In tree in yard 200 m W of prematernity roost (16)	NV. 145 m N in bitternut hickory or white oak tree (12)
4010	Shed	NV. 185 m NE in small American elm trees (11)	Shed	Shed	X	X
4004	100 m NE in cluster of dead white oak leaves 2.5 m off ground in sm dead tree (9)	NV. 50 m N in bitternut hickory or white or red oak tree (4)	NV. 70 m N in bitternut hickory or sugar maple (6)	Radio on ground 50 m E		
4002	X	NV. 60 m N in bitternut hickory (5)	X	X	X	X
4007	95 m SE in cluster of dead red oak leaves in American elm 3 m off ground (1)	Same as 28 May (1)	X	X	X	X
6151	40 m NE in cluster of dead white oak leaves in sm tree 2.5 m off ground (roosting with 1 other bat) (3)	Same as 28 May (3)	X	X	X	\X
6155	X	X	X	X	X	X
Total # Bats in shed	6	4	2	2	0	0

Figure 2.—Eastern Pipistrelle A6151 roosting with another untagged Eastern Pipistrelle in a cluster of dead oak leaves about 2.5 m off the ground.

relatively long staging periods following emergence from hibernation and prior to entering leaf clusters. During this time they may form small temporary colonies (prematernity colonies) in or on buildings prior to moving to the clusters of dead leaves (foliage roost sites) in which they give birth. We believe that the main function of this behavior is to serve as a permanent gathering place for the bat colony because there is no main summer roost to return to since the clusters are temporary and do not remain in place from year to year. The leaf clusters utilized were located in the vicinity of the prematernity roost; all were within 200 m of the Lowery roost.

In addition, since warmer roost temperatures speed gestation (Racey 1973), it has been suggested that the function of the prematernity colonies might be to provide a more stable microclimate than the leaf clusters. However, the Parshall-Layton and Clifty Falls colonies are both exposed to the elements. The Lowry colony is located in a shed, thus the microclimate may be more stable there. The prematernity colonies are or will be maternity colonies, but differ in that they break up prior to using leaf clusters (Veilleux & Veilleux 2004b; Veilleux

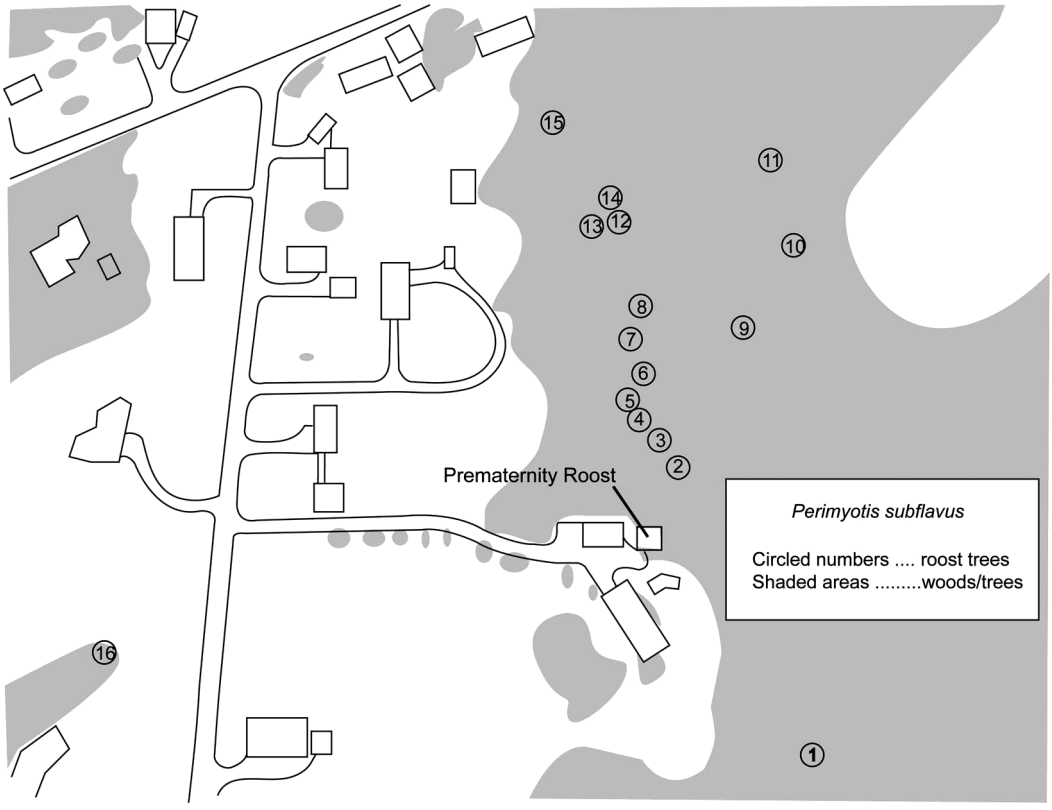

Figure 3.—Prematernity roost and roost trees of *Perimyotis subflavus* southwest of Clinton, Vermillion County, Indiana.

Table 4.—Observations of Eastern Pipistrelles at Clifty Falls State Park, Jefferson County, Indiana: 2001–2003. There was a single bat present on 28 April 2002. N = no observations.

		2001	2002	2003
May	1			2
	2			4
	3			5
	4			3
	5		5	N
	6		N	5
	7		8	4
	8		N	5
	9		N	6
	10		11	N
	11		11	5
	12		N	N
	13	0	N	N
	15	0	N	7
	16	0	N	10
	17	0	N	9
	18	0	N	5
	19	0	N	N
	20	5	11	N
	21	N	0	7
	22	N	0	12
	23	10		13
	24	0		0
	25	0		0
	26			
	27			
	28			
	29			
	30			
	31			
June	1			
	2			
	3	13		
	4			
	5	13		
	6			
	7			
	8	2		

et al. 2003). We know of no other bat species that behaves this way.

Whitaker (1998) reported parturition of Eastern Pipistrelles in maternity colonies in buildings occurring between 30 May and 11 July, with most young born between 12 June and 1 July. In Indiana, the earliest parturition in foliage roosting Eastern Pipistrelles was reported in late June (29 and 26 June, 1999 and 2000, respectively; Veilleux & Veilleux 2004b). The dates in buildings (Whitaker 1998) may be related to higher and more stable temperatures than are probably found in foliage roosts; Eastern Pipistrelles in foliage may receive higher exposure to the cooling effects of wind and rain (Veilleux et al. 2003).

Bats in prematernity roost sites showed annual fidelity to these sites. One bat banded in 1998 at the Parshall-Layton colony returned to the roost for five successive years and three bats banded in 1999 were later observed there in 2001 and 2003. At the Lowry colony, seven of 13 bats banded in 2002 returned in 2003, and four of the original bats were present at the roost five years later in 2008, along with one that was banded in 2003.

We suspect that originally these bats formed prematernity colonies using large trees or other environmental markers and then moved from there into nearby areas with ample leaf clusters where they had their young. With the advent of buildings, prematernity colonies became associated with these structures (inside or outside) and spread from there to nearby areas with leaf clusters. The Parshall-Layton prematernity colony disappeared in 2003, after the nearby trees were removed.

It is not known why these bats split up into the small groups in leaf clusters, but it is probably because clusters of leaves are so small as compared to buildings. It appears that the bats have evolved to fit leaf clusters, as suggested by their color which resembles that of dead leaves. The splitting of a colony into small numbers in leaf clusters could be a means of avoiding predation or a seeking of sites with favorable temperature and humidity conditions. Our samples are small, but there is no evidence that the bats in the prematernity colonies mix with pipistrelles forming maternity colonies in buildings.

Barclay & Kurta (2007) describe three broad types of roost switching by bats: episodic (between various life episodes such as hibernation to maternity colonies or to staging sites, or after the young become volant), emergency (to avoid a predator such as a raccoon or snake), and recurrent (such as back and forth from tree to tree). The prematernity colonies described here appear to be an example of an episodic roost switching behavior, with the prematernity colonies forming after hibernation and prior to the dispersal to foliage roost sites.

Big Brown and Little Brown bats may have entered buildings accidentally or while searching for places to roost and found them suitable as

maternity roost sites, and they are now the bats that commonly roost in buildings. However, a few do form maternity colonies in buildings or under bridges. Eastern Pipistrelles may have taken a different approach to the adoption of roosts in buildings by gathering in or on buildings as prematernity colonies and then in some instances remaining in buildings as maternity roosts. It would be a simple behavioral change from forming prematernity colonies in buildings, to using buildings for production of young.

ACKNOWLEDGMENTS

We thank Peter Parshall, Andrea and Richard Layton, and the Lowry family for access to their properties and for keeping us informed about the bats. We would like to thank Royce Whitaker for helping with banding and recording bats, and for editorial help. Also, we thank Allen Kurta for reading earlier versions of the manuscript. Angela Chamberlain read earlier versions and helped in final editing of the manuscript. Tim Carter read the manuscript and gave a number of valuable suggestions. Linda Castor prepared the figures. Laura Bakken helped greatly by preparing the manuscript for submission and also by applying her editorial skills.

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Manuscript received 20 January 2014, revised 3 July 2014.