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VARIANCE AND REPLENISHMENT OF NECTAR IN WILD AND GREENHOUSE POPULATIONS OF *MIMULUS*

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ABSTRACT—We compared nectar production in wild populations and greenhouse-grown populations of the monkey flower species of section *Erythranthe* of the genus *Mimulus*. Nectar was sampled from over 1000 flowers. For each flower the volume of nectar was measured with a calibrated micropipette and the percentage of sugar with a hand refractometer. Percentage of sugar varied little from flower to flower in both field and greenhouse studies, but volume varied markedly from flower to flower in field studies and even more in greenhouse studies. This high variance in nectar volume appears to be intrinsic. The amount of nectar in greenhouse populations tended to increase with time in the absence of pollinators. The amount of nectar in field populations tended to remain the same with time despite withdrawals by pollinators. Thus, nectar appears to be replenished both with time and as a response to pollinator withdrawals. The latter conclusion was corroborated by sampling nectar at 2-h intervals all day and comparing the total volume produced by a flower to the volume of nectar produced in control flowers sampled only at the end of the day.

Key words: Mimulus, *nectar, nectar volume, nectar variance, nectar replenishment, pollinator reward.*

Nectar is the primary reward for the principal pollinators, hummingbirds and bumblebees, of flowers such as the monkey flowers of section *Erythranthe* of the genus *Mimulus* (Scrophulariaceae), based on our own observations and as suggested by Free (1970), Faegri and Van Der Pijl (1979), and Baker (1983). Pollen is a secondary reward, particularly for bumblebees, but the analysis of its effect on attracting pollinators was beyond the scope of this study. Here we concentrate on the nectar rewards of the species of the section.

Five of the six species of section *Erythranthe—Mimulus cardinalis, M. eastwoodiae, M. nelsonii, M. rupestris,* and *M. verbenaceus*—have red, tubular, hummingbird-pollinated flowers, whereas the two races of the sixth species, *M. lewisii,* have light lavender pink or deep magenta pink, open, bumblebee-pollinated flowers (Hiesey et al. 1971, Vickery 1978, Vickery and Wullstein 1987). All the species are self-compatible but usually do not self-pollinate. So, pollinators are required for normal seed set (Vickery 1990).

To characterize the nectar rewards of this group, we examined (1) the standing crop of nectar present in flowers of wild and greenhouse-grown populations of each species and (2) the ability of flowers to replenish their nectar levels.

METHODS

For field studies, flowers of a population of each species and race (Table 1) were analyzed in the wild for their nectar characteristics. Nectar volume was measured with a calibrated micropipette. Percentage of sugar in the nectar was determined with a hand refractometer. Measurements were made on different fresh flowers at 2-h intervals all day from dawn to dusk (Appendix 1). Flowers were sampled destructively inasmuch as we found that merely probing the flower with a micropipette failed to remove the occasionally sizeable remainder of nectar (Table 2).

Greenhouse studies were undertaken to avoid the variable of unequal numbers of pollinator visits and variations of climate observed in studies of wild populations. Different fresh flowers of greenhouse-grown populations of each species and race (Table 1) were sampled at 2-h intervals from bud stage (bumblebees often probe and rob buds) until flowers fell or shriveled (Appendix 2). Again, flowers were sampled destructively to be comparable to field studies as well as to obtain as complete measurements of the volume and as accurate measurements of the percentage of sugar of the nectar as possible.

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TABLE 1. Localities of populations used in the study by species, population number, habitat, locality, elevation, and collector. Vouchers are in the Garret Herbarium (UT) of the University of Utah, Salt Lake City.

***Mimulus cardinalis* Douglas**	
6651	Growing by stream, Bear Wallow picnic area, Santa Catalina Mtns., Pima Co., Arizona, elev. 2130 m. Collected by Charles T. Mason, Jr., 2143.
7113	Los Trancos Creek, San Mateo Co., California, elev. 40 m. Collected by Malcom Nobs February 1958.
7120	South face of San Antonio Peak, Los Angeles Co., California, elev. 2250 m. Collected by Verne Grant 9760.
13106	Growing by spring, Aguage Vargas, Cedros Island, Baja California del Norte, Mexico, elev. 600 m. Collected by Steven Sutherland 25 October 1981.
13486	Growing along road to the Pacific Ocean, ca 2 miles west of turnoff from El Camino Real, Santo Tomas, Baja California del Norte, Mexico, elev. ca 500 m. Collected by Steven Sutherland 20 February 1984.
***Mimulus eastwoodiae* Rydberg**	
6079	Growing in seeps under overhanging sandstone cliffs, Bluff, San Juan Co., Utah, elev. 1415 m. Collected by R. K. Vickery, Jr., 800.
13514	Growing in seeps in sandstone shelter caves near Anasazi ruins, south side of river, Bluff, San Juan Co., Utah, elev. 1375 m. Collected by Steven Sutherland May 1985.
***Mimulus lewisii* Pursh**	
5875	Growing along small stream where Patsy Morley ski trail crosses Albion Basin Road, Alta, Salt Lake Co., Utah, elev. 2680 m. Collected by R. K. Vickery, Jr., 2723.
6103	Growing along effluent stream from Ice Lake, Soda Springs, Placer Co., California, elev. 2000 m. Collected by R. K. Vickery, Jr., 1361.
13515	Smoky Jack campground, Yosemite National Park, California, elev. ca 1800 m. Collected by Steven Sutherland 24 March 1986.
***Mimulus nelsonii* Grant**	
6271	Growing in and by a small brook in the pine forest on Devil's Backbone, Sierra Madre Occidental, Durango, Mexico, elev. 2555 m. Collected by R. K. Vickery, Jr., 2614.
***Mimulus rupestris* Greene**	
9102	Growing on moist, conglomerate cliff, ca 100 m below the Tepozteco Temple, Tepoztlan, Morelos, Mexico, elev. 2300 m. Collected by R. K. Vickery, Jr., 2738.
Mimulus verbenaceus	
5924	Growing by Bright Angel Creek near Phantom Ranch, Grand Canyon, Arizona, elev. 612 m. Collected by Earl Jackson November 1954.
13518B	Growing near stream, Oak Creek Canyon, Coccino Co., Arizona, elev. ca 1800 m. Collected by Steven Sutherland April 1985.
13547	Growing by spring emerging from a talus slope at base of red sandstone canyon wall, Vassey's Paradise, below Lee's Ferry, Grand Canyon, Arizona, elev. 1015 m. Collected by Steven Sutherland 20 April 1986.

Wild and greenhouse nectar studies suggested to us that nectar replacement might occur in response to removal of nectar by pollinators. So, nectar volume and percentage of sugar were measured repeatedly on flowers of greenhouse-grown populations. Flowers were gently probed (not destructively sampled) with micropipettes. Each flower was probed every 2 h from 0800 to 1600 h, nectar characteristics recorded, and nectar volumes summed (Appendix 3). At 1600 h previously unsampled control flowers were gently probed in the same manner and nectar characteristics recorded for comparison to the repeatedly sampled flowers (Appendix 3). *Mimulus* flowers of section *Erythranthe* typically develop in pairs at each node of the flower stem, except in *M. eastwoodiae* and *M. rupestris*. One flower was repeatedly sampled and the other used as the control wherever possible. Occasionally, fluctuating asymmetry between members of a pair led to one flower developing more rapidly than the other. Usually the flowers developed synchronously and to the same size as Møller and Pomiankowski (in press) suggest for developmentally stable, pollinator-visited flowers such as *Mimulus*. It was important to use flowers of the same size and developmental stage inasmuch as they produce more nectar than smaller flowers of pairs exhibiting fluctuating asymmetry (Møller and Pomiankowski in press)

For the statistical analyses two tests were employed. F-tests were used to compare variances of the pairs of wild populations and greenhouse populations for nectar volumes

TABLE 2. Comparison of nectar volume obtained by probing the flower vs. volumes obtained by destructively sampling the flower. Flowers were probed with a micropipette and then destructively sampled to obtain the remainder of nectar present. Greenhouse-grown plants were used.

	#1 flower		#2		#3		#4		#5		Volume
	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	x̄
M. cardinalis–7113											
initial probe	7.0	24.5	3.0	24.5	0.0	0.0	2.0	21.4	5.5	16.0	8.4
remainder	0.8	29.0	0.5	20.6	0.0	0.0	0.0	0.0	0.5	14.0	0.4
M. cardinalis–7120											
initial probe	7.0	17.1	9.0	19.1	6.5	18.8	8.5	17.0	9.0	7.0	8.0
remainder	12.0	17.2	26.0	19.4	17.0	19.0	14.0	17.1	26.0	7.7	19.0
M. cardinalis–6651											
initial probe	6.0	14.0	6.0	18.6	3.0	20.2	0.2	10.0	—	—	3.8
remainder	5.5	14.0	8.5	18.6	0.2	17.0	4.0	20.5	—	—	4.5
M. eastwoodiae–6079											
initial probe	0.0	0.0	1.0	25.0	0.5	34.0	7.0	17.0	7.0	14.0	3.1
remainder	0.8	21.2	0.0	0.0	1.0	27.4	3.5	17.0	5.0	14.0	2.0
M. lewisii–6103											
initial probe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
remainder	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
M. lewisii–5875											
initial probe	0.0	0.0	0.7	15.3	0.7	10.6	0.8	8.0	0.8	29.2	0.6
remainder	0.1	26.0	0.3	14.0	0.0	0.0	0.0	0.0	0.2	29.0	0.1
M. nelsonii–6271											
initial probe	7.0	16.3	4.7	18.8	8.5	16.0	1.2	14.0	—	—	5.4
remainder	12.5	16.2	1.6	19.0	1.0	16.0	1.4	13.2	—	—	4.1
M. rupestris–9102											
initial probe	0.0	0.0	1.0	34.0	2.2	25.2	0.0	0.0	0.0	0.0	0.6
remainder	0.0	0.0	0.8	29.2	1.5	25.6	3.0	25.8	5.5	28.1	2.1
M. verbenaceus–5924											
initial probe	7.0	24.5	3.0	24.5	0.0	0.0	2.0	21.4	5.5	16.0	3.5
remainder	0.8	29.0	0.5	20.6	0.0	0.0	0.0	0.0	0.5	14.0	0.4

and sugar concentrations (Tables 3, 4). The *F*-test is particularly suitable to test variances (Sokal and Rohlf 1981). The null hypothesis was that observed variances of the wild and greenhouse populations sampled the same statistical population. The *F*-test was also used to compare nectar volumes and sugar concentrations at successive 2-h intervals during the day. The Tukey-Kramer procedure (Lehman et al. 1989) was used to compare nectar volumes and sugar concentrations of greenhouse-grown representatives of the various species and races to each other (Table 5). This method uses average sample sizes and is to be preferred to the T′-method or GT-2 method for comparisons of unequal sample sizes, according to Sokal and Rohlf (1981).

RESULTS AND DISCUSSION

Wild Populations

Observations of the standing crop of nectar in flowers of wild populations revealed significant differences in nectar volumes but not sugar concentrations among some populations but not others (Tables 3, 4, 5). *Mimulus lewisii* (both races), *M. rupestris*, and *M. eastwoodiae* formed one group with low nectar volumes that were insignificantly different from each other. *Mimulus nelsonii* and *M. cardinalis* formed a second group with significantly higher volumes. *Mimulus verbenaceus* bridged the two groups with intermediate nectar volumes. In general, the more tubular and brighter red the flowers, the greater the volume of nectar and the more frequent the visits by hummingbirds, although this varied from population to population and locality to locality. Conversely, the more open and pinker the flowers, the less the volume of nectar and the more frequent the visits of bumble or carpenter bees.

Despite general trends, actual numbers of pollinator visits to flowers of wild populations varied markedly. Specifically, in an average of 3 h of observation each of *M. rupestris* (9102), *M. cardinalis* (13106), and *M. eastwoodiae* (6079), no pollinator visits were observed at all. In 2 h of observations each of *M. verbenaceus* (13518B) and *M. nelsonii* (6271) 3 and 7 visits, respectively, by hummingbirds were

TABLE 3. Summary of nectar volumes (standing crops) produced by flowers of wild populations and greenhouse-grown populations of the species of section *Erythranthe*. ↑ = significantly higher variance and ↓ = significantly lower variance in the greenhouse-grown population than in the wild population.

Wild populations				Greenhouse populations[a]				Variances equal	
Population number (Table 1)	Sample size (n)	Mean volume (μl)	Standard deviation	Population number	Sample size (n)	Mean volume (μl)	Standard deviation	F ratio	Probability
M. cardinalis									
13486	80	12.08 ± 1.34	± 11.00	*13106*	40	50.78 ± 1.89	± 13.71	1.7330	.1906
M. eastwoodiae									
13514	88	1.10 ± 0.17	± 1.16	*6079*	27	6.41 ± 0.31	± 2.58	45.1157	.0000 ↑
M. lewisii—Sierra Nevada race									
13515	69	0.60 ± 0.21	± 0.63	*6103*	22	2.29 ± 0.38	± 3.52	41.5997	.0000 ↑
M. lewisii—Rocky Mountain race									
5875	121	0.97 ± 0.07	± 0.74	*5875*	127	1.54 ± 0.07	± 0.81	0.7317	.3932
M. nelsonii									
6271	155	16.10 ± 1.16	± 15.39	*6271*	38	19.26 ± 2.34	± 9.44	4.5126	.0349 ↑
M. rupestris									
9102	13	0.99 ± 0.78	± 1.54	*9102*	55	5.42 ± 0.38	± 3.02	7.0458	.0099 ↓
M. verbenaceus									
13518B	65	7.27 ± 1.21	± 6.05	*13547*	43	42.49 ± 1.49	± 13.67	29.4422	.0000 ↓

[a]Values for nectar volumes in unopened buds (see Appendix 2) are omitted from these data.

recorded but no bee visits. In the populations of *M. lewisii*, 7 hummingbird and 232 bumblebee visits were observed in 13 1/2 h of observations of population 13513 of the Sierra Nevada race, and 2 hummingbird and 12 bumblebee visits were observed in 4 1/4 h of observation of population 5875 of the Rocky Mountain race. The highest number of pollinator visits was observed in the Santo Tomas population (13486) of *M. cardinalis* with 600+ visits by hummingbirds and 70+ visits by bumblebees in the course of 4 1/2 h of observation. All observations were made for 15-min periods scattered from dawn to dusk. Each population had at least 200 flowers in bloom. The number of pollinator visits to a population depends strongly on the guild of pollinators in that area at that time. For example, the Santa Tomas area was alive with pollinators, whereas Cedros Island lacked them almost completely.

Nectar volume varied so much from flower to flower (Appendix 1) that pollinators would have to visit each flower in order to ascertain its nectar reward. Actually, pollinators appear to be cueing in on shapes and/or colors that promise an acceptable reward, on average, but not necessarily from each flower visited. Variances were so high for nectar volumes that one standard deviation approached the population mean in magnitude in all populations (Table 3). In contrast, variation in sugar concentration was far less. It was less than one-fifth the magnitude of the mean on average (Table 4). High variances in nectar volume could be due to unequal visits by pollinators; variations in soil moisture; climatic factors such as wind, dew, or rain; or microclimatic variations in humidity around the flowers (Cruden and Hermann 1983, Wyatt et al. 1992).

As a day progressed, from as early as 0600 to as late as 2000 (Appendix 1), the mean volume of nectar in flowers of wild populations changed little despite withdrawals by pollinators, evaporation, dilution, stimulation by climatic factors (Table 6), or, possibly, by reabsorption of nectar by the nectaries (Búrquez and Corbet 1991). Specifically, the nectar volume remained essentially unchanged in flowers of four populations: *M. eastwoodiae*, *M. nelsonii*, *M. rupestris*, and *M. verbenaceus*. It decreased, as would have been anticipated for all populations, if replenishment were not occurring, in only two populations, *M. cardinalis* and the Sierra Nevada race of *M. lewisii*. It actually rose in one population, the Rocky Mountain race of *M. lewisii*. The increase in volume was

TABLE 4. Summary of nectar sugar concentrations (standing crops) produced by flowers of wild populations and greenhouse-grown populations of the species of section *Erythranthe*. ↑ = significantly higher variance and ↓ = significantly lower variance in the greenhouse-grown population than in the wild population.

Wild populations				Greenhouse populations[a]				Variances equal	
Population number (Table 1)	Sample size (n)	Mean concentration (%)	Standard deviation	Population number	Sample size (n)	Mean concentration (μl)	Standard deviation	F ratio	Probability
M. cardinalis									
13486	80	12.86 ± 0.42	± 3.82	*13106*	40	20.78 ± 0.59	± 3.54	0.3136	.5766
M. eastwoodiae									
13514	88	16.14 ± 0.91	± 8.90	*6079*	27	18.97 ± 1.65	± 7.27	3.4170	.0671
M. lewisii—Sierra Nevada race									
13515	69	12.07 ± 0.68	± 4.46	*6103*	22	13.72 ± 1.21	± 8.53	18.6158	.0000 ↑
M. lewisii—Rocky Mountain race									
5875	121	16.97 ± 0.93	± 8.32	*5875*	127	33.05 ± 0.90	± 11.74	12.3031	.0005 ↓
M. nelsonii									
6271	155	19.94 ± 0.33	± 3.97	*6271*	38	17.92 ± 0.66	± 4.55	0.4615	.4977
M. rupestris									
9102	13	18.98 ± 2.54	± 14.09	*9102*	55	17.53 ± 1.23	± 7.64	5.8744	.0181 ↓
M. verbenaceus									
13518B	65	14.42 ± 0.45	± 4.48	*13547*	43	17.32 ± 0.55	± 1.61	26.4864	.0000 ↑

[a]Values for sugar concentrations in unopened buds (See Appendix 2) are omitted from these data.

not due to dilution inasmuch as there was no corresponding decrease in sugar concentration (Table 6). The only species showing a decrease in sugar concentration was *M. rupestris*, which, however, showed no significant rise in nectar volume. These observations suggest to us that flowers are producing additional nectar both as the day advances and/or as pollinators remove it.

Greenhouse-grown Populations

Flowers of the greenhouse-grown populations had, as an overall average, more than three times the volume of nectar found in flowers of wild populations, but essentially the same levels of sugar concentration. In three populations, 5875 of the Rocky Mountain *M. lewisii*, 6271 of *M. nelsonii*, and 9102 of *M. rupestris* (Table 1), direct comparisons could be made between greenhouse-grown plants and plants in wild populations because greenhouse plants were either transplants or grown from seeds collected from the same wild populations. These greenhouse plants exhibited about twice the volume of nectar recorded for corresponding wild plants. In the other four populations only indirect comparisons were possible. In these cases wild populations came from similar habitats but different localities than the greenhouse-grown populations of the same species or race (Table 1). Greenhouse-grown plants exhibited over four times the volume of nectar found in their wild counterparts. Presumably the increase in nectar volume in both groups of populations when grown in the greenhouse reflects lack of nectar withdrawals in the greenhouse due to absence of pollinators and to more standardized and more consistently favorable climatic, soil moisture, and humidity conditions in the greenhouse. Higher relative humidity has been shown to lead to higher nectar production in *Ascelpias syriaca* (Wyatt et al. 1992). The increased nectar was more dilute in *Ascelpias* in contrast to the *Mimulus* nectar, which remained at essentially the same sugar concentration. Relative humidity in our greenhouse was typically 65%, but ranged up or down by 15%. Relative humidity at Moab, the closest station to our locality at Bluff, averaged 19%, with ranges of 11–80% on average (Utah Climate Center 1993). This was during July and August (1993), the *Mimulus* flowering season. It is small wonder that nectar production for that desert population rose significantly higher, nearly sixfold, in our humid greenhouse

TABLE 5. Comparisons of mean nectar volumes and mean nectar sugar concentration of the species of *Mimulus* of section *Erythranthe* using the Tukey-Kramer test (Sokal and Rohlf 1981). Positive values show pairs of means that are significantly different.

	Volume						
	nelsonii	*cardinalis*	*verbenaceus*	*eastwoodiae*	*rupestris*	*lewisii* R. Mtn.	*lewisii* Sierras
nelsonii	–5.2141						
cardinalis	–2.3365	–7.1398					
verbenaceus	1.8260	–2.8556	–9.0312				
eastwoodiae	7.9089	3.1797	–3.0400	–8.2443			
rupestris	9.5366	4.6160	–1.7667	–6.9066	–5.6009		
lewisii— R. Mtn.	8.0589	3.3297	–2.8900	–8.0943	–7.0387	–8.2443	
lewisii— Sierras	8.8322	4.0631	–2.1927	–7.3825	–6.2735	–7.5325	–7.6327

	Sugar concentration						
	nelsonii	*rupestris*	*lewisii* R. Mtn	*eastwoodiae*	*verbenaceus*	*cardinalis*	*lewisii* Sierras
nelsonii	–8.0453						
rupestris	–7.3070	–8.6421					
lewisii— R. Mtn.	–7.8996	–9.1731	–12.7208				
eastwoodiae	–5.9996	–7.2731	–10.8208	–12.7208			
verbenaceus	–5.5712	–6.8299	–10.2783	–12.1783	–13.9349		
cardinalis	–2.4944	–3.7911	–7.4909	–9.3909	–11.2158	–11.0165	
lewisii— Sierras	–2.1016	–3.3875	–7.0176	–8.9176	–10.7241	–10.5711	–11.7772

(Table 3). Relative humidity at Park City, the closest station to our Alta locality, during the July–August flowering season for *Mimulus* averaged 46% with ranges of 17–85% on average (Utah Climate Center 1993). Nectar production in the greenhouse was slightly, but insignificantly, higher than nectar production in the wild for this pair of populations. Relative humidity appears to help set the limit on how much of a flower's potential for nectar production is realized. There was no indication of nectar reabsorption.

Greenhouse populations exhibited much the same groupings of nectar volume producers as did wild populations. That is, *M. eastwoodiae*, *M. lewisii* (both races), and *M. rupestris*, were the low producers; *M. cardinalis* and *M. verbenaceus* were the high producers; and *M. nelsonii* was the intermediate producer.

In all but two cases variance in nectar volumes increased significantly in greenhouse-grown populations compared to wild populations (Table 6). This occurred despite lack of pollinators. Variability in the standing crop of nectar appears to be intrinsic and not simply due to uneven nectar withdrawal by pollinators. Variability in nectar volume might function as a strategy to insure pollinator visits to many flowers of a population (Wiens personal communication); that is, the psychological principle of intermittent rewards would seem to be operating (Edward Cook personal communication).

In flowers of greenhouse-grown populations sugar concentrations varied insignificantly. They tended to remain in the range of 12–20% (Appendix 2).

Nectar Replenishment

Nectar replenishment is indicated by the general maintenance of nectar volumes despite nectar removal in wild populations and by the tendency of nectar volumes to increase in the absence of pollinators in greenhouse-grown populations (Table 6).

Comparison of nectar volumes produced when flowers were probed with a micropipette every 2 h until the late afternoon—like a pollinator removing nectar—with flowers that were not probed at all until the late afternoon demonstrated that repeatedly probed flowers produced at least twice as much nectar as flowers that were probed only once (Appendix 3). While nectar volume apparently

TABLE 6. Changes in floral nectar volume (μl) and percent (%) sugar with time, during the course of a day (Appendices 1, 2). ↑ equals a significant increase with time and ↓ equals a significant decrease with time.

Species	Wild populations			Greenhouse populations		
	Mean	*F* ratio	*p*	Mean	*F* ratio	*p*
M. cardinalis						
Santo Tomas	12.0812 μl	27.5578	.0000 ↓	—	—	—
	12.8637%	0.4307	.5136	—	—	—
Cedros Island	—	—	—	50.7675 μl	1.2138	.2775
	—	—	—	20.7850%	16.9257	.0002 ↑
M. eastwoodiae						
San Juan	1.1068 μl	3.3306	.0715	—	—	—
	16.1454%	0.8536	.3581	—	—	—
Bluff	—	—	—	6.2462 μl	20.1851	.0001 ↑
	—	—	—	19.2392%	0.1186	.7334
M. lewisii—Sierra						
Yosemite	0.6028 μl	4.0774	.0475 ↓	—	—	—
	12.0753%	0.0679	.7953	—	—	—
Ice Lake	—	—	—	2.2909 μl	2.6352	.1202
				13.7272%	4.8804	.0390 ↓
M. lewisii—Rocky Mtns.						
Alta	0.9719 μl	5.1894	.0245 ↑	6.2464 μl	20.1851	.0001 ↑
	16.9743%	2.1025	.1497	19.2392%	0.1186	.7334
M. nelsonii						
Sierra Madre	16.1045 μl	0.0568	.8119	19.2657 μl	0.3331	.5674
	19.9412%	1.4890	.2243	17.9263%	5.9106	.0202 ↑
M. rupestris						
Tepozteco	0.9923 μl	0.0159	.9018	5.4163 μl	2.7497	.1032
	18.9846%	8.0010	.0164 ↓	17.5345%	1.1780	.2827
M. verbenaceus						
Oak Creek	7.2333 μl	0.8416	.3624	—	—	—
	14.3757 %	3.9155	.0521	—	—	—
Grand Canyon	—	—	—	46.3830 μl	12.0601	.0009 ↑
	—	—	—	17.8630%	19.7339	.0000 ↑

increases with time alone (see above), volume increases more rapidly with repeated removals.

The amount of nectar produced by flowers in successive 2-h periods tended to decrease in *M. cardinalis, M. eastwoodiae, M. nelsonii,* and *M. verbenaceus* (Appendix 3). The percentage of sugar dropped in only two cases, the 7120 population of *M. cardinalis* and the 6271 population of *M. nelsonii.* Apparently, production of additional nectar is not achieved, with these possible exceptions, by dilution, but reflects the actual synthesis of more nectar. Consequently, calculations of the amount of sugar produced by a flower depend not only on volume of nectar and percent sugar at the time of sampling (Bolten et al. 1979, Sutherland and Vickery 1993), but also on the amount of sampling and hence the amount of replenishment of nectar in that flower.

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(Appendices 1–3 follow on pages 220–227.)

APPENDIX 1. Standing crop of nectar in flowers of wild populations of the species and races of section *Erythranthe* of the genus *Mimulus* at different times of day. Time is given in terms of a 24-hour clock, volume of nectar is in microliters (μl), and sugar concentration of the nectar in percent sugar (%). Data were gathered by Steven Sutherland in 1986-87.

***M. cardinalis*—Santo Tomas, Baja California, del Norte, Mexico**

	0600		0800		1000		1200		1400		1600		1800		2000	
	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%
	8.5	18.0	10.0	8.0	13.5	12.2	4.0	11.6	3.0	9.0	8.0	14.8	1.0	8.0	3.0	13.0
	43.5	16.8	6.5	6.6	18.0	11.2	49.5	14.2	19.0	19.2	3.5	14.8	1.5	12.4	3.0	12.4
	46.0	16.2	16.0	12.0	7.5	14.8	8.5	20.4	8.0	9.6	1.5	9.0	1.5	16.2	22.0	13.6
	22.5	10.0	25.0	13.2	6.5	9.6	21.5	14.3	5.5	13.0	1.0	7.4	2.0	21.0	9.0	15.4
	12.0	15.6	4.5	12.2	4.0	14.0	32.5	12.8	4.0	7.6	1.0	10.4	4.0	14.2	11.5	17.2
	34.0	16.6	11.0	11.4	6.5	10.4	13.5	14.4	22.5	14.8	8.5	11.2	5.0	6.8	14.0	19.2
	13.0	12.4	35.0	14.0	7.0	9.0	3.0	11.0	21.0	23.8	7.0	8.0	4.0	5.0	6.5	17.2
	18.5	9.0	40.0	16.4	11.5	6.4	13.0	12.4	6.5	13.0	3.5	13.4	4.0	7.4	5.0	14.6
	29.0	14.0	16.0	12.2	10.0	11.2	7.0	14.2	8.0	16.8	3.5	15.4	6.0	13.4	10.5	16.4
	20.5	14.2	13.0	9.6	23.5	14.8	5.5	12.2	10.0	7.2	3.5	7.4	7.0	9.0	7.0	21.4
$\bar{x}$ =	24.8	14.3	17.7	11.6	10.8	11.4	15.8	13.8	10.8	13.4	4.1	11.2	3.6	11.3	9.2	16.0

***M. eastwoodiae*—Bluff, Utah**

	0800		1000		1200		1400		1600		1800	
	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%
	7.3	17.6	0.3	13.8	0.2	21.6	0.3	27.2	1.0	14.4	1.2	17.2
	2.0	18.2	0.9	33.0	1.3	12.4	0.4	17.0	1.2	11.8	1.2	12.8
	1.0	15.4	2.5	31.2	1.8	33.0	0.3	26.6	0.6	3.8	1.0	6.8
	0.6	7.0	2.3	11.4	0.7	18.2	0.2	5.4	0.3	2.0	2.5	12.0
	0.8	14.0	0.5	5.6	0.5	23.8	1.0	10.4	0.7	7.4	1.2	12.8
	1.3	5.2	1.4	11.2	0.6	22.4	0.3	25.2	0.6	9.2	1.3	18.6
	0.6	10.0	0.8	7.2	4.5	28.0	0.4	22.0	2.6	25.0	0.8	26.0
	0.3	10.4	1.2	8.4	2.4	17.4	1.8	9.0	0.2	7.6	0.1	9.0
	0.6	6.8	0.6	5.2	4.3	33.0	0.5	21.8	1.2	10.0	2.5	8.8
			1.3	20.2	1.2	33.0	0.4	19.0	1.8	11.2	0.6	23.0
$\bar{x}$ =	1.6	11.6	1.2	14.7	1.7	24.3	0.5	18.3	1.0	10.2	1.2	14.7

***M. lewisii*—Yosemite, California**

	0600		0800		1000		1200		1400		1600		1800	
	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%
	0.1	6.0	0.3	10.0	0.7	9.4	0.4	14.0	0.8	11.4	0.7	9.0	0.5	10.6
	3.2	10.8	1.2	10.6	1.3	10.2	1.2	14.6	0.1	7.4	0.4	9.0	1.0	12.2
	0.2	5.0	0.8	10.0	1.2	29.4	0.2	16.4	0.8	10.8	0.2	15.2	0.5	12.2
	1.4	17.4	2.0	22.6	0.5	7.0	0.1	16.2	0.2	13.2	0.1	6.0	0.3	16.8
	0.5	16.4	0.2	6.0	0.2	8.4	0.2	12.6	0.1	11.4	0.1	10.8	0.1	9.4
	0.8	20.2	0.3	10.2	1.6	26.8	0.1	14.0	0.3	12.2	0.1	4.0	0.2	15.2
	1.0	13.2	0.3	12.4	0.2	10.8	0.6	13.6	0.2	11.0	0.2	11.2	0.1	12.8
	1.0	5.2	0.3	8.6	0.4	11.0	0.1	14.0	2.7	16.8	0.1	16.0	1.5	10.8
	0.3	11.6	0.3	10.4	0.2	9.4	0.1	13.6	0.2	9.0			0.6	12.8
$\bar{x}$ =	0.9	12.0	0.7	11.3	0.8	13.1	0.3	13.9	0.5	11.1	0.2	10.3	0.6	12.6

***M. lewisii*—Alta, Utah**

	0600		0800		1000		1200		1400		1600	
	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%
	0.3	15.1	0.2	3.6	0.8	14.4	0.5	14.8	0.4	21.2	2.4	20.2
	1.1	9.2	0.1	7.6	0.8	27.2	2.2	15.2	1.7	11.0	1.4	20.4
	0.8	10.8	0.2	13.8	1.4	24.2	0.5	19.6	0.8	11.8	0.4	19.4
	2.8	15.4	0.2	7.6	0.2	9.0	0.2	6.0	1.3	10.2	1.2	20.8
	3.0	12.1	2.2	8.6	0.3	20.2	0.8	10.2	0.1	11.0	3.2	20.8
	0.7	25.8	1.0	27.2	0.9	25.0	0.5	33.0	0.2	29.2	2.0	20.8
	0.4	17.6	0.6	7.4	2.2	9.0	0.2	10.2	1.6	8.2	0.8	14.4
	0.8	20.0	0.2	12.8	2.3	16.4	1.0	15.2	0.3	33.0	1.3	21.2
	0.8	12.6	0.2	6.8	0.4	33.0	1.0	7.0	1.2	15.2	1.2	21.4
	0.6	4.0	0.3	3.3	0.9	19.2	1.5	15.0	0.6	16.0	0.4	11.0
$\bar{x}$ =	1.1	14.2	0.5	9.9	1.0	19.8	0.8	14.6	0.8	16.7	1.4	19.0

APPENDIX 1. Continued.

***M. nelsonii*—Sierra Madre Occidental, Sinaloa**

	0600		0800		1000		1200		1400		1600		1800		2000	
	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%
	12.3	18.4	32.3	21.4	12.4	16.8	10.8	16.8	2.1	17.0	5.2	20.2	12.3	18.4	32.3	21.4
	7.3	15.6	6.1	17.0	30.2	19.0	44.0	18.0	2.8	17.0	4.4	21.2	7.3	15.6	6.1	17.0
	22.0	30.4	15.0	70.2	10.6	17.0	23.6	15.2	12.0	17.6	6.2	25.4	22.0	30.7	15.0	20.2
	5.5	20.0	15.4	18.8	14.0	15.4	32.4	18.2	2.0	17.2	11.3	23.8	5.5	20.0	15.4	18.8
	2.9	16.4	27.6	16.0	11.3	15.8	22.6	16.6	2.1	25.4	2.6	20.2	2.9	16.4	27.6	16.0
	3.7	15.6	53.5	17.8	5.7	19.8	4.7	15.0	2.5	21.0	2.7	19.0	3.7	15.6	53.5	17.8
	14.6	21.6	12.7	20.0	5.8	16.8	7.3	19.4	33.2	23.4	3.4	18.2	14.6	21.6	12.7	20.0
	27.5	27.0	1.0	25.2	2.2	16.6	6.9	17.6	4.3	20.8	2.5	15.8	27.5	27.0	1.0	25.2
	10.8	21.2	10.0	18.3	2.4	16.0	12.7	17.6	14.5	29.2	3.2	23.2	10.8	21.2	10.0	18.2
	5.0	21.6	1.7	18.4			2.4	16.2	4.2	29.0	2.7	20.2	5.0	21.6	1.7	18.4
$\bar{x}$ =	11.2	20.8	17.5	19.3	11.3	17.0	16.7	17.0	8.0	21.8	4.4	20.7	11.2	20.8	17.5	19.3

***M. rupestris*—Tepozteco, Morelos**

	1000		1200		1400	
	Vol.	%	Vol.	%	Vol.	%
	0.3	20.2	0.7	14.2	5.6	22.2
	0.3	32.0	2.6	18.4	0.2	6.0
	1.3	55.2	0.3	6.0	0.3	15.2
	0.4	32.0	0.1	6.0	0.2	11.4
					0.6	8.0
$\bar{x}$ =	0.6	34.8	0.9	11.1	1.4	12.6

***M. verbenaceus*—Oak Creek Canyon, Arizona**

	0800		0900		1200		1400		1600	
	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%
	13.3	13.0	1.0	13.0	19.5	13.2	11.7	12.2	2.6	22.2
	4.3	15.0	0.2	7.0	9.7	13.2	0.7	21.2	11.4	16.8
	2.4	14.0	0.3	6.0	5.4	11.2	0.7	12.2	6.3	16.4
	14.0	17.2	4.3	11.8	18.3	12.4	2.5	12.2	2.0	12.2
	3.6	16.8	0.5	9.8	9.4	8.4	4.0	12.2	17.0	15.8
	1.8	24.4	7.4	17.4	7.8	12.4			2.4	24.0
	0.7	6.8	9.2	17.0	8.5	12.8			3.1	18.2
	1.5	12.0	5.0	16.2	10.6	25.8			10.1	10.2
	7.0	13.0	10.2	14.6	7.3	12.4			3.0	21.4
	5.2	13.2	13.4	16.4	1.6	12.4			26.8	16.8
$\bar{x}$ =	5.4	14.6	5.1	12.9	9.8	13.4	3.9	14.0	8.5	17.4

APPENDIX 2. Standing crop of nectar in flowers of greenhouse-grown populations of the species and races of section *Erythranthe* of the genus *Mimulus* at different ages. Age is given in hours (24-hour clock) before and after 0600 on the morning of bud break. Volume of nectar is in microliters (μl) and sugar concentration of the nectar in percent sugar (%).

***M. cardinalis* (13106)—Cedros Island, Baja California del Norte, Mexico**

Day −1			Day +1			Day +2			Day +3			Day +4		
Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%
−18	37.4	15.8	0	53.9	16.2	24	68.8	18.2	48	30.0	19.2	72	53.9	27.4
−18	40.0	17.0	2	44.5	18.0	26	43.8	17.2	48	85.6	12.2	74	52.9	23.0
−16	18.8	15.6	4	37.1	22.2	26	22.2	17.2	50	37.8	21.6	76	52.2	29.8
−16	28.3	16.2	6	51.0	21.8	28	50.0	18.8	50	73.1	16.4	78	64.5	24.2
−14	30.8	16.2	8	50.0	18.2	28	26.9	19.2	52	66.4	17.6	80	45.6	28.0
−14	36.6	14.0	10	38.8	18.2	30	45.3	20.6	52	50.6	15.8	82	39.9	25.8
−12	22.1	16.4	10	42.3	22.6	30	59.4	22.2	54	50.8	22.2			
−12	22.1	16.4	12	61.3	18.2	32	57.6	20.0	54	31.9	22.2			
						32	43.0	21.6	56	54.7	22.2			
						34	49.4	20.6	56	51.8	21.2			
						34	35.2	21.2	58	50.0	24.2			
						36	77.9	19.0	58	69.0	24.0			
									60	64.8	23.6			
									60	46.8	19.6			
x̄ =	29.5	16.0		47.4	19.4		48.3	19.7		54.5	20.1		51.5	26.4

***M. eastwoodiae* (6079)—Bluff, Utah**

Day −1			Day +1			Day +2			Day +3			Day +4			Day +5		
Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%
−24	0.3	35.4	0	3.5	25.4	32	1.8	26.4	48	6.4	22.8	72	9.4	14.9	96	8.8	22.7
−22	1.9	28.0	4	2.9	20.0				50	5.1	14.0	74	8.0	18.6	98	10.9	20.2
−20	2.1	30.4	6	3.2	18.6				52	4.8	31.4	76	5.0	10.3	100	8.0	27.3
−18	3.5	19.4	8	4.2	21.6				54	5.3	13.4	78	5.0	8.1	100	10.0	11.3
−16	0.6	22.8	10	4.5	15.8				56	10.4	6.0	80	6.0	17.1	102	8.8	14.8
−14	0.9	47.2	12	1.8	30.2				58	7.5	13.4	82	8.4	16.4	104	2.2	33.0
−12	1.7	25.0										84	7.2	13.1	106	8.6	20.6
															108	7.2	31.3
x̄ =	1.6	29.7		3.4	21.9		1.8	26.4		6.6	16.8		7.0	14.1		8.1	22.7

APPENDIX 2. Continued.

***M. lewisii* (6103)—Ice Lake, California**

Day –1			Day +1			Day +2			Day +3			Day +4		
Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%
–24	0.1	11.0	0	0.3	17.4	24	0.6	22.0	48	0.2	32.0	74	2.8	8.8
–22	0.1	6.0	2	0.2	7.0	26	0.4	20.8	50	0.8	12.2	82	0.2	5.0
–20	0.2	25.0	4	0.4	22.8	28	0.8	17.8	52	11.6	3.4			
–18	0.1	16.0	6	4.3	3.8	30	1.5	12.0	54	11.8	1.0			
–16	0.2	21.4	8	1.2	16.2	34	0.9	13.0	56	1.7	13.0			
–14	0.2	16.0	10	0.2	25.4	36	1.4	13.4	58	0.7	3.0			
–12	1.0	23.6	12	0.4	25.4				60	8.0	6.6			
$\bar{x}$ =	0.3	17.0		1.0	16.9		0.9	16.5		5.0	10.2		1.5	6.9

***M. lewisii* (5875)—Alta, Utah**

Day –1			Day +1			Day +2		
Age	Vol.	%	Age	Vol.	%	Age	Vol.	%
–24	0.4	24.8	0	1.4	20.0	24	3.1	24.4
–24	0.5	26.4	0	2.0	14.8	24	2.9	26.2
–22	3.7	11.0	2	0.9	20.8	26	1.9	29.4
–20	1.8	10.2	4	0.4	20.0	28	0.5	59.0
–20	1.2	10.4	4	1.8	18.0	28	1.2	43.0
–18	1.0	13.0	6	1.7	14.8	30	3.1	34.2
–18	1.2	10.2	6	1.5	26.8	30	3.3	36.6
–18	1.9	10.8	8	1.9	28.0	32	0.6	45.6
–16	2.7	16.0	8	1.2	28.2	32	0.3	48.8
–16	1.5	16.2	10	1.4	26.2	34	0.6	50.2
–14	2.6	9.4	10	1.2	34.0	34	0.6	58.8
–14	2.6	9.4	12	2.2	28.6	36	0.7	56.0
–12	2.2	11.0	12	1.8	26.2	36	0.6	51.2
–12	2.4	12.2						
$\bar{x}$ =	1.9	13.9		1.5	22.9		1.4	44.0

APPENDIX 2. Continued.

M. nelsonii **(6271)—Sierra Madre, Durango, Mexico**

Day –1			Day +1			Day +2			Day +3			Day +4			Day +5		
Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%
–22	3.2	18.2	2	9.9	20.2	26	33.6	20.6	50	27.4	16.2	76	10.5	18.0	100	22.0	19.0
–20	0.3	22.4	4	14.5	14.0	26	13.0	19.2	50	18.4	22.4	76	10.5	18.0	102	10.6	28.0
–20	18.6	12.2	6	20.0	16.8	28	12.6	15.2	52	40.0	17.6	78	29.2	15.4			
–20	9.7	14.0	6	16.6	12.2	28	16.3	25.6	52	22.4	19.0	78	5.8	29.4			
–18	5.3	12.0	8	10.2	17.6	30	10.4	16.6	52	23.6	14.4	82	28.3	21.0			
–18	1.7	23.2	8	15.8	12.6	30	27.3	12.4	54	14.1	30.4						
–16	6.9	12.2	8	3.5	18.2	32	26.5	12.2	56	31.8	15.6						
–14	5.3	13.4	10	27.8	19.6	32	38.4	15.6	58	23.6	15.2						
			12	13.5	12.4	34	13.6	18.2									
						34	19.5	15.0									
$\bar{x}$ =	6.4	16.0		14.6	16.0		21.1	17.0		25.2	18.9		15.7	19.6		16.3	23.5

M. rupestris **(9102)—Tepozteco, Morelos, Mexico**

Day –1			Day +1			Day +2			Day +3			Day +4			Day +5		
Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%
–24	1.7	15.8	0	3.9	15.6	24	3.0	18.4	48	2.6	22.4	72	8.4	15.6	96	6.0	14.0
–24	3.2	17.0	2	2.2	22.8	26	7.0	14.8	48	10.9	11.0	74	5.5	9.0	96	3.5	10.6
–22	0.0	0.0	4	3.2	24.8	28	3.6	21.2	50	12.2	9.6	74	0.6	34.0	98	2.2	26.8
–22	1.2	21.2	4	3.6	15.4				50	9.5	11.2	76	5.6	14.4	98	2.2	31.8
–20	0.0	0.0	6	4.7	8.2				52	6.1	15.4	76	7.3	9.8	100	1.6	34.0
–20	0.4	22.8	6	3.9	17.4				52	6.4	15.2	78	7.7	12.8	100	1.2	34.0
–18	0.0	0.0	8	1.6	23.6				54	5.3	13.4	78	6.1	22.0	102	3.6	28.2
–18	1.8	21.0	8	4.9	17.4				56	4.9	15.4	80	6.4	13.8	102	7.8	16.0
–16	0.0	0.0	10	5.2	14.2				56	1.6	18.8	80	9.2	10.6	104	1.8	38.6
–14	0.6	17.4	10	4.0	15.0				58	6.4	15.2	82	11.4	1.6	104	13.4	12.0
–12	0.0	0.0	12	2.7	14.8				58	4.3	29.4	82	6.8	16.2	106	10.8	15.0
–12	1.0	33.0	12	2.5	20.2				60	7.7	10.2	84	9.2	7.2	106	1.6	26.0
									60	5.7	14.8	84	7.7	12.4	108	5.6	17.2
															108	5.1	15.0
$\bar{x}$ =	0.8	12.4		3.5	17.5		4.5	18.1		6.4	15.5		7.1	13.8		4.7	22.8

APPENDIX 2. Continued.

***M. verbenaceus* (5924)—Grand Canyon, AZ**

Day −1			Day +1			Day +2			Day +3			Day +4			Day +5			Day +6			Day +7		
Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%	Age	Vol.	%
−18	10.0	13.2	0	32.1	15.4	24	50.8	16.0	48	47.9	16.0	72	55.2	18.8	96	76.4	19.4	120	61.7	20.1	144	76.6	15.8
−18	5.6	13.2	2	38.2	17.8	26	30.3	13.8	50	47.7	17.8	74	60.0	18.8	98	67.9	19.4	122	17.8	25.0	146	37.8	24.6
−16	23.9	14.0	4	27.9	15.6	26	26.2	15.8	52	51.3	18.6	74	41.0	16.8	98	60.0	19.2	124	23.9	15.2	148	13.9	25.2
−16	5.5	13.4	6	19.5	14.0	28	45.7	14.8	54	42.2	16.8	76	57.9	18.2	100	21.3	15.4	126	60.4	16.6			
−14	5.2	14.8	8	64.5	17.4	28	38.3	16.2	56	59.0	18.6	76	63.6	17.0	102	35.6	20.4	128	56.1	19.0			
−14	6.6	14.4	10	15.7	18.0	30	44.9	16.2	58	43.0	18.2	78	60.0	17.8	102	72.1	16.8	130	60.0	16.8			
−12	12.7	15.6	10	26.1	16.8	30	35.5	17.0	60	50.0	19.2	78	69.7	17.8	104	40.6	17.0	130	61.3	18.6			
−12	22.2	15.2	12	35.7	16.4	32	38.8	17.4	60	54.7	18.8	80	40.0	19.0	104	43.2	15.8	132	61.8	18.2			
			12	22.9	17.8	32	37.9	15.4				80	18.8	15.0	106	70.8	17.2						
						34	25.3	18.6				82	67.8	17.8	106	70.0	19.6						
						34	40.9	16.8				82	48.3	19.4	108	57.9	20.2						
						36	36.2	17.4				84	43.5	20.8	108	81.4	17.6						
						36	37.5	17.8				84	34.8	21.2									
$\bar{x}$ =	11.5	14.2		31.4	16.6		37.6	16.4		49.5	17.9		50.8	18.3		58.1	18.2		50.4	18.7		42.8	21.9

APPENDIX 3. Nectar production in flowers of greenhouse-grown plants under repeated sampling every 2 h versus only one sampling at 1600 h.

	0800		1000		1200		1400		1600		Totals		1600 only	
Population	μl	%	μl	%	μl	%	μl	%	μl	%	Σ, μl	%, x	μl	%
7113-19	9.5	13.5	7.0	12.0	0.2	3.8	1.0	12.0	0.1	14.0	17.8	11.0	4.0	21.3
7113-19	8.0	16.4	3.5	11.2	8.0	14.4	1.5	13.8	0.3	4.0	21.3	12.0	8.0	17.5
7113-19	2.0	18.0	1.0	10.0	1.5	16.0	3.0	18.0	9.6	17.1	17.1	15.8	3.0	25.4
7113-20	2.5	19.8	6.5	19.1	9.2	16.5	3.5	15.2	0.4	15.0	22.1	17.1	9.0	20.0
7113-20	1.2	13.6	3.5	13.0	4.0	14.0	2.8	15.0	0.1	7.0	11.6	12.5	9.2	24.3
7113-31	2.0	14.6	0.3	5.3	1.5	13.0	4.4	23.3	1.0	10.7	9.2	11.1	4.0	18.2
$\bar{x}$ =	4.2	16.0	3.6	11.7	4.1	13.0	2.7	16.2	1.9	11.3	16.5	13.2	6.2	21.1
7120-25	4.8	14.8	4.0	13.0	3.0	12.6	6.0	11.3	2.7	12.2	20.5	12.8	9.0	17.0
7120-25	3.5	18.6	9.0	18.2	5.0	15.6	9.5	13.7	4.5	12.3	31.5	15.7	10.2	16.1
7120-25	1.0	11.0	2.6	12.3	1.5	11.0	0.7	14.0	1.2	10.2	7.0	11.7	8.0	14.8
7120-28	2.0	17.7	0.6	11.2	5.0	15.1	5.0	16.4	2.6	15.0	15.2	15.0	9.0	16.2
7120-24	9.6	18.4	8.0	16.4	9.5	16.0	0.5	12.3	0.3	2.6	27.9	13.1	9.0	18.1
7120-28	8.8	14.5	2.0	9.0	2.5	12.0	2.5	13.1	4.0	12.0	19.8	12.1	4.5	15.0
$\bar{x}$ =	4.9	15.8	4.3	13.3	4.4	13.7	4.0	13.4	2.5	10.7	20.3	13.4	8.3	16.2
6651-9	10.0	13.0	8.0	10.6	3.0	7.4	1.0	13.8	1.0	13.4	23.0	11.6	0.2	7.0
6651-11	9.0	17.5	10.0	16.6	8.0	17.0	9.8	16.0	2.5	14.5	39.3	16.3	9.5	14.6
6651-15	1.0	23.4	1.0	20.6	1.5	20.4	4.0	17.5	9.5	17.0	17.0	19.8	9.2	20.3
6651-21	9.0	15.8	11.5	15.2	7.0	14.0	10.8	15.0	0.5	12.0	38.8	14.4	6.5	16.0
6651-21	8.0	15.9	4.0	14.5	8.6	13.4	3.0	13.6	9.0	16.0	32.6	14.7	4.5	15.7
6651-10	2.5	12.7	2.5	12.7	3.0	11.0	1.2	12.8	0.3	13.0	9.5	12.4	8.0	16.2
$\bar{x}$ =	6.6	16.4	6.1	15.0	5.2	13.9	5.0	14.8	3.8	14.3	26.7	14.8	6.3	14.9
6079-23	2.5	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	1.3	6.0	6.0
6079-10	0.4	26.0	0.7	23.6	0.8	18.5	0.0	0.0	0.0	0.0	1.9	13.6	8.5	13.6
6079-10	2.0	9.0	2.0	8.7	1.5	9.4	1.0	9.8	0.0	0.0	6.5	7.4	1.1	26.0
6079-23	0.0	0.0	0.7	12.7	2.5	17.6	3.5	14.1	1.0	13.0	7.7	11.5	3.0	11.4
6079-10	9.5	6.1	4.0	5.2	0.1	7.0	0.0	0.0	0.0	0.0	13.6	3.6	8.2	7.2
6079-21	0.5	8.1	7.5	7.5	3.0	7.0	0.9	9.3	1.0	8.0	12.9	8.0	4.0	12.0
$\bar{x}$ =	2.5	9.3	2.5	9.6	1.3	9.9	0.9	5.5	0.3	3.5	7.5	7.5	5.1	12.7
6103-130	1.0	34.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	6.8	0.0	0.0
6103-186	0.5	34.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	0.3	6.3
6103-130	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.3	0.0	0.0
6103-130	0.0	0.0	0.0	0.0	0.0	0.0	0.7	31.0	0.0	0.0	0.7	0.3	0.0	0.0
6103-119	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6103-186	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$\bar{x}$ =	0.2	11.3	0.0	0.0	0.0	0.0	0.1	5.1	0.0	0.0	0.3	2.3	0.1	1.0
5875-246	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5875-239	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5875-246	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	34.0	0.2	6.8	0.0	0.0
5875-263	0.1	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.2	34.0
5875-262	0.4	34.0	2.0	11.7	0.0	0.0	0.0	0.0	0.1	8.0	2.5	10.7	0.0	0.0
5875-202	0.0	0.0	0.0	0.0	0.1	1.0	0.1	7.0	0.0	0.0	0.2	1.6	0.1	13.0
$\bar{x}$ =	0.1	6.1	0.3	2.0	0.0	0.1	0.0	1.1	0.1	7.0	0.3	3.2	0.1	7.8
6271-25	6.0	18.4	8.0	17.0	5.0	16.0	2.0	15.0	4.0	15.1	25.0	16.3	9.3	16.4
6271-8	10.8	15.5	4.5	15.4	9.0	14.3	11.5	13.2	9.3	12.0	45.1	14.0	8.5	15.3
6271-10	7.5	13.8	9.2	13.0	10.0	13.0	5.0	13.5	1.0	10.4	32.7	12.7	0.1	0.0
6271-28	2.5	16.8	0.5	17.0	3.5	16.3	0.7	7.0	1.2	14.3	8.4	14.3	7.0	9.6
6271-31	7.0	19.0	2.2	15.0	2.0	13.1	2.0	12.6	0.8	11.8	14.0	14.3	5.0	11.0
6271-28	8.2	17.0	13.0	15.6	9.7	14.0	7.0	12.6	1.8	12.5	39.7	7.9	9.4	14.2
$\bar{x}$ =	7.0	16.8	6.2	15.5	6.5	14.5	4.7	12.3	3.0	12.7	27.5	13.2	6.5	11.1