SURVEYS OF ELLIPTICAL CRATER POPULATIONS ON THE SATURNIAN SATELLITES AND MERCURY. R. R. Herrick[1] and P. M. Schenk[2], [1] Geophysical Institute, University of Alaska Fairbanks, Fairbanks, AK 99775-7320 (rherrick@gi.alaska.edu); [2]Lunar and Planetary Institute, 3600 Bay Area Blvd. 77058 (schenk@lpi.usra.edu).

Introduction: Planetary impacts that occur at the lowest impact angles with respect to horizontal produce craters that are elliptical in planform with the long axis oriented in the downrange direction. Experimental hypervelocity impacts into a strengthless medium suggested that craters should become elliptical for impact angles < ~5° [1]. Bottke et al. [2] conducted surveys of the crater populations on the Moon, Venus, and Mars, and found that ~5% of the craters on those bodies had ellipticities $\varepsilon > 1.2$ (ellipticity is the ratio of the major axis to the minor axis of the crater rim). Assuming the impactor populations are striking the planets from random directions, these percentages suggest that planetary craters become elliptical for impact angles as high as 12°. Bottke et al. [2] hypothesized that the discrepancy was attributable to a higher impactor/crater diameter ratio on the planets than in the experiments of [1]. Here we attempt to expand the range of impact velocities and target properties for the planetary data by conducting surveys similar to [2] for five Saturnian moons and Mercury.

Saturnian Satellites Data: We utilized global mosaics constructed from Cassini flybys for the Saturnian moons Mimas, Tethys, Dione, Rhea, and Iapetus. The global mosaics were produced with pixel sizes ranging from 400 – 1000 m/pixel, although in some areas the image resolution was far worse than this. The mosaics were reprojected into a Mercator projection (shape-preserving) and then craters were outlined and fit with an ellipse. We only outlined craters for which 1) the crater shape was clearly distinguishable, meaning its planform has mostly not been superposed by later craters; 2) the target terrain does not appear to have been so rugged as to have clearly distorted the final crater shape; and 3) the crater has not been noticeably deformed by subsequent tectonics (rifting). Although all of these moons are heavily cratered, only a modest percentage of the craters were well enough preserved to meet these criteria. We were only able to obtain reliable outlines for craters with D > 10 km in most of the mosaics.

Figure 1 shows crater diameter versus ellipticity for Rhea, the largest of our surveys. Table 1 summarizes the results of the surveys.

Mercury Data: To provide as much of an "apples to apples" comparison as possible with the Saturnian data, we conducted a survey of a portion of the surface imaged by MESSENGER Flyby 1 NAC Departure Mosaic #1 with a nominal resolution of 550 m, as this seems to provide a comparable resolution and viewing geometry to the Saturnian data. Our preliminary survey results for ~30º of longitude are summarized in Table 1, and Figure 2 shows diameter versus ellipticity.

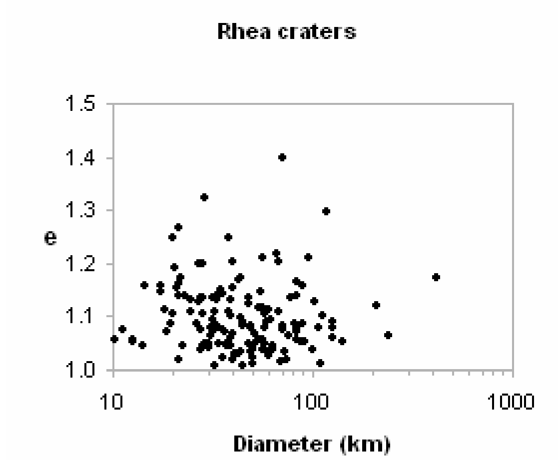

Figure 1. Ellipticity of craters on Rhea versus major axis diameter.

Table 1. Raw counts of crater ellipticity for five Saturnian moons and the planet Mercury.

Body	Craters	ε > 1.2	ε > 1.3	ε > 1.5
Mimas	77	6	3	1
Tethys	65	8	1	1
Dione	143	12	2	0
Rhea	122	4	2	0
Iapetus	35	4	0	0
Total	442	34	8	2
Mercury	273	15	2	2

Discussion: In Table 2 we show the approximate percentages of craters above three ellipticity thresholds for our surveys and the compilations of Bottke et al. [2]. There are a number of caveats to be considered when evaluating the data. The percentages of elliptical craters for the Moon, Mars, and Venus were estimated for relatively flat, unsaturated surfaces where the craters were not overlapping (e.g., lunar mare). However, no such surfaces exist on the Saturnian satellites, and the Mercury survey was conducted on a mix of highlands and smooth plains units. We expect that rugged terrain could distort the planforms of some craters and thus increase the numbers of moderately elliptical craters. The surveys are conducted without regard to whether craters are simple or complex, and the percentages of simple versus complex craters varies between surveys. Details of the methodologies used in [2] to collect the data are different for each planet and different from our procedures.

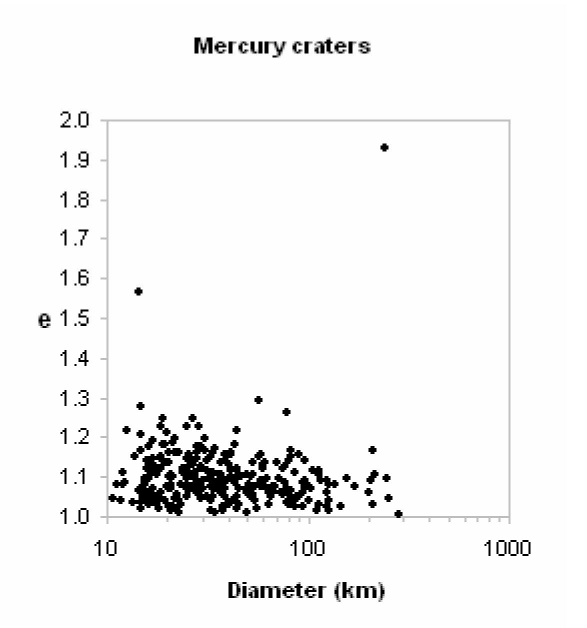

Figure 2. Ellipticity of Mercurian craters versus major axis diameter.

Table 2. Comparison of percentages of elliptical craters with results from Bottke et al. [2] for the Moon, Mars and Venus (NA indicates not enough information to determine; D column is diameter range in km).

Body	D (km)	ε > 1.2	ε > 1.3	ε > 1.5
Moon	2 - 90	5.4%	2.2%	1.5%
Mars	> 5	~4	~3.5	~2.7
Venus	> 20	4.4	NA	0.7
Saturn moons	> 7	7.7	1.8	0.4
Mercury	> 10	5.5	0.7	0.7

Nevertheless, there is general agreement between the terrestrial planets and the Saturnian moons in finding that ~5% of craters have ε > 1.2. However, there are significant discrepancies in how elliptical the elliptical craters are. In particular, on all of the terrestrial planets we could find clear examples of pristine highly elongated craters with a major axis double the length of the minor axis. However, on the Saturnian satellites we found only two craters with ε > 1.5, and both of those are poorly preserved and arguably two superposed circular craters (e.g., Fig. 3). Also, an interior linear ridge indicative of a low-angle complex crater can be found in craters with ε ≈ 1.2 on Saturnian moons (e.g., Fig. 3), but a similar feature is only observable in terrestrial complex craters with ε > 1.8 (e.g., Fig. 4). Thus, we conclude that the very lowest angle impacts form less elliptical craters on the Saturnian moons than the terrestrial planets. If ellipticity is reduced by higher cratering efficiency (the basic hypothesis of Bottke et al.), then the very low gravity of the small Saturnian moons may account for our observations. We hope to address some of our caveats and hypotheses with similar surveys on Ganymede and the lunar highlands.

References: [1] Gault D.E. and Wedekind J.A. (1978) *Proc. LPSC 9th*, 3843-3875. [2] Bottke W.F. et al. (2000) *Icarus, 145,* 108-121.

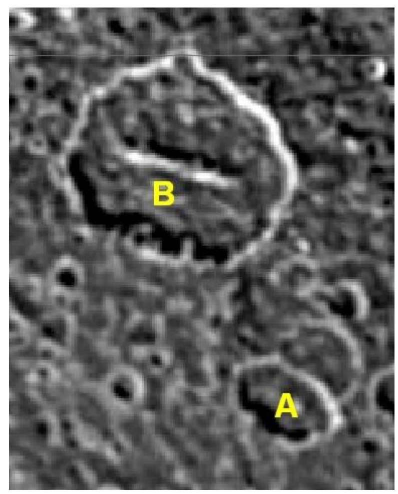

Figure 3. Craters on Iapetus. Crater A has ε = 1.7 but may be two joined craters. Crater B (70 x 59 km) has an interior linear ridge and ε = 1.2.

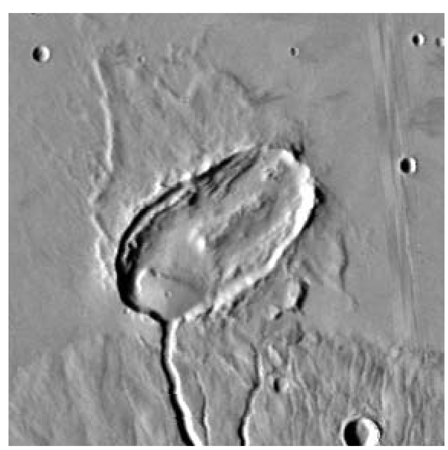

Figure 4. This Martian crater (35 x 18 km) has an interior linear ridge and ε = 1.9.