Table 2
Comparison of the values for the coefficients (A and p) of power-law fits to peak-ring basins on the Moon (this study) and Mercury (Baker et al., 2011). Power laws are of the form given in Eq. (1) in the text. Coefficients of power-law fits to protobasins and ringed-peak cluster basins on Mercury from Baker et al. (2011) are also given, but none are given for the Moon due to the statistically small populations. Coefficients from the power law model of an expanding melt cavity (Eq. (2), Section 7) on the Moon (this study) and Mercury (Baker et al., 2011) are given for calculations using the Croft (1985) and Holsapple (1993) scaling relationships.

	Power-law coefficients[a]		
	A	p	R^2
Peak-ring basins			
Moon[b]	0.14 ± 0.10	1.21 ± 0.13	0.96
Mercury[c]	0.25 ± 0.14	1.13 ± 0.10	0.87
Protobasins (⩾90 km)			
Moon	–	–	–
Mercury	0.26 ± 0.36	1.09 ± 0.29	0.69
Ringed peak-cluster basins			
Moon	–	–	–
Mercury	0.18 ± 0.34	1.02 ± 0.41	0.78
Model (Croft, 1985)			
Moon	0.14 + 0.03/−0.02	1.09 ± 0.05	–
Mercury	0.14 + 0.03/−0.02	1.09 + 0.05/−0.06	–
Model (Holsapple, 1993)			
Moon	0.11	1.18	–
Mercury	0.11 − 0.12	1.18	–

[a] Power laws are of the form $D_{ring} = A(D_r)^p$, where D_{ring} is the ring diameter and D_r is the final (observed) rim-crest diameter. Uncertainties for power-law fits to peak-ring basins, protobasins and ringed peak-cluster basins are at 95% confidence.
[b] Coefficients to fits and models for the Moon are from this study. No fits were made to the protobasin and ringed peak-cluster data for the Moon because of the statistically small populations.
[c] Coefficients to fits and models for Mercury are from Baker et al. (2011).

($D_{ring} = 0.25 \pm 0.14(D_r)^{1.13\pm0.10}$, Fig. 4B and Table 2), and both fits are consistent with analyses of previous peak-ring basin catalogs (Pike, 1988). Since the population of protobasins on the Moon is statistically small ($N = 3$), fits to the protobasin data were not conducted. However, protobasins occur at smaller diameters than all peak-ring basins but overlap in rim-crest diameter with the largest complex craters on the Moon (Fig. 4A). The trend in ring diameter and rim-crest diameter for protobasins is aligned with the tail-end of the peak-ring basin trend (Fig. 4A). This supports the view that peak-ring basins and protobasins are parts of a continuum of basin morphologies. A similar observation is identified between protobasins and peak-ring basins on Mercury (Fig. 4B), where the power law fits to protobasins and peak-ring basins are found to be statistically indistinguishable (Table 2) (Baker et al., 2011). However, protobasins on Mercury are more numerous, and protobasins <90 km have anomalously smaller ring diameters than what is predicted by extrapolation of a power law fit to protobasins ⩾90 km.

The one lunar ringed peak-cluster basin, Humboldt, occurs at smaller rim-crest and ring diameters than peak-ring basins but is larger in rim-crest diameter than all three protobasins (Fig. 4A). Humboldt has an atypically small interior ring diameter relative to its rim-crest diameter and thus plots on a trend that is more aligned with the trend for central peak diameters in complex craters than the interior rings of peak-ring basins (Fig. 4A). Other craters with ring-like central peaks also plot near the trend for central peak diameters in lunar complex craters. Fig. 4A shows two trends for central peak diameters in lunar complex craters. The first is the least squares, linear regression of Hale and Head (1979a) ($D_{cp} = 0.259D_r - 2.57$, where D_{cp} is the diameter of the central peak and D_r is the diameter of the crater's rim crest), which was based on measurements of circular fits to the maximum diameter of central peaks in fresh complex craters on the Moon. Because the measurements were of the maximum diameter of central peaks, the trend of Hale and Head (1979a) is taken to represent an upper limit to central peak diameters on the Moon. The second trend is a power law [$D_{cp} = 0.107(D_r)^{1.095}$] determined using the planform areas enclosed by the irregular perimeters of central peaks calculated by Hale and Grieve (1982). We then assume a circular geometry for this area, from which a central peak diameter is derived. These central peak diameters are taken to represent an average value, and should produce results that are comparable to our method for measuring the average diameters of basin features on the Moon. Craters with ring-like central peaks appear to fall on a scattered trend that is intermediate between the Hale and Head (1979a) linear regression and the Hale and Grieve (1982) power law (Fig. 4A), indicating that these ring-like central peaks do not depart substantially from the trend in central-peak diameter observed from complex craters. Humboldt falls near the Hale and Grieve (1982) trend, suggesting a similarity with complex craters with central peaks. However, the clear ring-like arrangement of its interior peaks, its large rim-crest diameter compared to other craters with ring-like central peaks, and its overlap with the rim-crest diameters of protobasins, suggest that Humboldt represents a unique transitional type in the size-morphology progression from complex craters to peak-ring basins. The fact that there is only one ringed peak-cluster basin on the Moon (5% of the total basin population cataloged in this study) is expected as it is likely to be related to the overall smaller numbers of protobasins and peak-ring basins on the Moon. For comparison, ringed peak-cluster basins account for only 8% of the total cataloged basin population on Mercury (Baker et al., 2011), and also fall along the trend for complex craters on Mercury (Fig. 4B).

6.2. Ring/rim-crest ratios

Rim-crest/ring ratio (or the inverse, ring/rim-crest ratio) plots (Fig. 5) have been used to suggest that protobasins and peak-ring basins represent a continuum of morphologies (Alexopoulos and McKinnon, 1994), in contrast to the view of Pike (1988), who favored a statistical distinction between peak-ring basins and protobasins. Alexopoulos and McKinnon (1994) identified a general trend of continuous, non-linearly decreasing rim-crest/ring ratios with increasing rim-crest diameter for protobasins and peak-ring basins on Venus. The basin catalogs of Wood and Head (1976), Hale and Head (1979b), Wood (1980), Hale and Grieve (1982), and Pike (1988) were also used to suggest similar trends for basins on Mercury, the Moon, and Mars, although the Moon and Mars data appeared with greater scatter (Alexopoulos and McKinnon, 1994). A recent comprehensive survey of 74 peak-ring basins and 32 protobasins on Mercury (Baker et al., 2011) further emphasized these observations by examining the inverse, ring/rim-crest ratios, and noted that peak-ring basins flatten to an equilibrium ring/rim-crest ratio value of around 0.5–0.6. As in Baker et al. (2011), we also calculate ring/rim-crest ratios (in contrast to the convention of using rim-crest/ring ratios from Alexopoulos and McKinnon (1994)), for consistency with earlier studies (Wood and Head, 1976; Pike, 1988) and to avoid magnifying the effects of errors in small denominators. Ring/rim-crest ratios from our refined lunar basin catalog (Fig. 5A) have less scatter than the catalogs used in Alexopoulos and McKinnon (1994), and reveal a trend that is very similar to that observed for Mercury (Fig. 5B) (Baker et al., 2011) and Venus (Fig. 5C) (Alexopoulos and McKinnon, 1994), although at larger rim-crest diameters. The ring/rim-crest ratios for peak-ring basins on the Moon range from 0.35 to 0.56 (arithmetic mean = 0.48), with smaller rim-crest diameters generally having smaller ratios than larger rim-crest diameters (Fig. 5A). The ring/rim-crest ratios on the Moon also flatten to a value of around 0.5 for the largest peak-ring basins. Protobasins have smaller ratios, ranging from