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Throat Patch Variation in Tayra (*Eira barbara*) and the Potential for Individual Identification in the Field

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Abstract: The importance of identifying individuals of a population has been extensively documented in several species of carnivores, including some species of mustelids. This information is used in many kinds of ecological studies including density estimation, behavioral ecology and analyses of animal movement patterns. The objective of the present study was to determine if individual variation in the throat patches of Tayra (*Eira barbara*) permits individual identification. We examined 275 specimens from museum collections to determine the morphological variation of the throat patch in *Eira barbara* specimens collected throughout its distribution. We found differences in the shape and size of the throat patches significant enough to allow discrimination of individuals that display a throat patch (88.0% of 252 complete specimens). The proposed identification criterion was applied to photographic records obtained from a wild population using camera traps in the Peruvian Amazon. From nineteen images (54.0% of all images) in which the throat patch was visible, nine different individuals were identified and two of these were recaptured on multiple occasions.

Keywords: Mustelidae; Carnivora; neotropical; Peruvian Amazon; non-invasive survey; camera traps

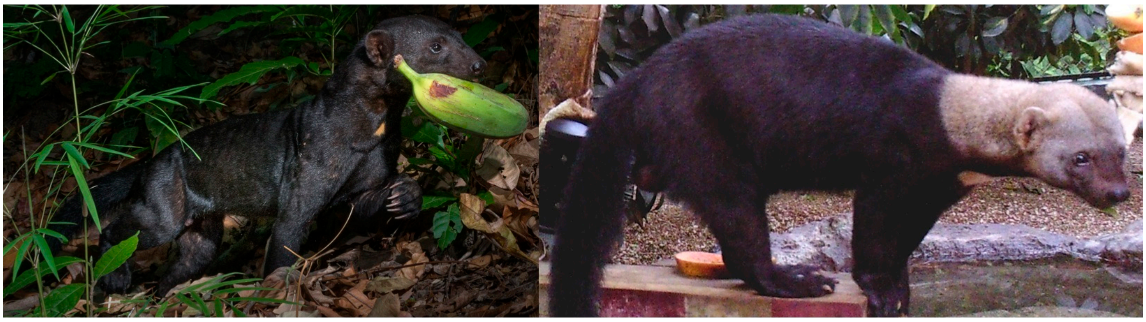
1. Introduction

Individual identification of free-living animals allows one to differentiate among individuals of a species and estimate the size of its population. One of the most commonly used procedures is the capture-recapture of individuals based on the Lincoln-Petersen method [1]. In a first sample, animals are captured, marked and released, and subsequently another sample of the population is captured. The proportion of individuals marked in the second sample permits the estimation of the total population size [2]. This basic model form was expanded to allow testing of various hypotheses about the factors influencing capture probability [3] and more recently to allow the incorporation of spatial information [4] yet the need for "capture" remains in all cases. Physical capture (and recapture) of individuals is not only invasive and potentially dangerous, but can be challenging or impossible in the case of many large and/or elusive mammals [5]. Fortunately non-invasive approaches exist for "capture" and "marking" of animals, and photo-identification, often through the use of motion/heat activated trail cameras, has been widely used in a capture-mark-recapture context to estimate population sizes (e.g., Testé and Denis [6]; Burton et al. [7]).

From photographic records, it is sometimes possible to characterize specific phenotypic patterns in an individual animal. In the case of mammals, some species have spots, rosettes or stripes on the coat, which are unique features and do not change with time [8,9]. As a result, photographic records can represent marking events, with subsequent photos representing recaptures. These photo records can then be analyzed to determine the number of different individuals of a species that were not only photographed but also missed. The information obtained from the individual identification of animals is essential in the study of animal behavior and population demographics [10].

There are examples in the literature of individual identification of wild mustelids (Carnivora: Mustelidae). Trujillo et al. [11] described individuals of the giant otter (*Pteronura brasiliensis*) with a uniquely patterned white-yellow chest patch. Magoun et al. [12] identified individuals of wolverine (*Gulo gulo*) through the observation of the unique light-colored patterns on the chest, throat, and chin area. Sirén et al. [13] recognized and contrasted individuals of American marten (*Martes americana*) through the analysis of the ventral patch on the chest and throat. Harrison [10] analyzed the pattern of the dorsal head stripes of the American badger (*Taxidea taxus*), identified individuals in the wild, and subsequently verified the difference of these characters among preserved individuals in a zoological collection.

The tayra (*Eira barbara*) is a neotropical scansorial (with terrestrial and arboreal habits) mustelid with a distribution that extends from the coasts of Central Mexico to northern Argentina (Figure A1). This species has variable coat color across its distribution that ranges from uniform (Figure 1a) to disruptive (Figure 1b). Seven subspecies based on coat coloration variation have been recognized throughout its range; three for Mexico to Panama, and the rest for South America (Table 1; [14–16]). Recent research based on analysis of mitochondrial DNA has reduced the number of subspecies in South America from five to two [17]. The exact number of subspecies remains questionable with their current geographical distribution and the status of their populations unknown.



(**a**) (**b**)

Figure 1. (**a**) Specimen of *Eira barbara* with uniform coloration (Nick Hawkins®); (**b**) Specimen with disruptive coloration (Villafañe-Trujillo®).

Eira barbara has been little studied and current records of the species include sightings, footprints and/or photographs through camera trapping, but are collateral results of research focused on other species [18–24].

Methods to identify individuals of *E. barbara* have yet to be reported. To date the identification of a specimen through photographic capture has only related to sex, provided the genitals of the organism are observed (e.g., Ramírez-Bravo [20]). The identification at the individual level using the phenotypic characteristics of *Eira barbara* is complicated. The color of the pelage of the head, neck, trunk, limbs, and tail is very similar, although in some geographic areas the tonality of the hair of the head and neck is different to the rest of the body. However, most populations of *E. barbara* have a distinct throat patch (Table 1), similar to that reported for other mustelids, where the feature has been successfully used for individual identification [11–13]. To date it has not been demonstrated whether throat patch variation in *Eira barbara* may allow discrimination between individuals, and whether the utility of the throat patch for this purpose varies geographically across the species' range.

Table 1. Names and descriptions of the seven subspecies of *Eira barbara* recognized by Cabrera [15] and Hall [16]; compiled by Presley [14].

Subspecies	Coloration				Presence of Throat Patch	Observations	Distribution **
	Body	Legs	Nape	Head			
barbara [1]	Dull brown	*	*	No distinct gray to brown	Yes, yellowish	Body is lighter than *E. b. sinuensis* and darker than *E. b. senex*	Paraguay, part of Brazil, Peru, Bolivia, and Argentina
sinuensis [2]	Black	*	Darker brown than the head.	*	May be present	Body is darker than *E. b. senex*	Panama, part of Costa Rica, Venezuela, Colombia, and Ecuador
poliocephala [3]	Dull brown	*	*	Brown	Yes, yellowish	Pelage is similar to that of *E. b. barbara* but with a darker yellow throat patch and yellow shoulder patches, which sometimes join forming a complete yellow collar	Guyana, French Guyana, Surinam, part of Brazil and Venezuela
peruana [4]	Dark chocolate brown	Darker than body	*	*	*	The color of the body is as in *E. b. madeirensis*, except that limb, are darker than body and tail is black	Part of Peru and Bolivia
senex [5]	Dark brown		Grayish white		Yes, yellowish	The grayish white color extends to shoulders fading to a dark yellow	Belize, part of Mexico, Guatemala, and Honduras
inserta [6]	Black	*	*	Dark brown	No	*	El Salvador, Nicaragua, part of Guatemala, Honduras and Costa Rica
madeirensis [7]	Dark chocolate brown	*	Slightly lighter than body		May be present	*	Part of Brazil, Venezuela, Colombia, Peru, and Ecuador

* = The original authors did not detail the description of the subspecies; ** = It represents an approximate distribution of the subspecies, obtained from maps generated by Cabrera [15] and Hall [16]; The subspecies are organized as described by different authors: [1] = Linnaeus, 1758; [2] = Humboldt, 1812; [3] = Traill, 1821; [4] = Nehring, 1886; [5] = Thomas, 1900; [6] = Allen, 1908 and [7] = Lunnberg, 1913.

The objective of the present study was to characterize the morphological variability of the throat patch of different museum specimens of *Eira barbara* collected throughout its range to determine if the throat patch character allows for the identification of individuals of this species. In addition, we aimed to investigate the applicability of our findings in a field setting, by attempting to identify individuals from camera trap photos collected in the Peruvian Amazon.

2. Materials and Methods

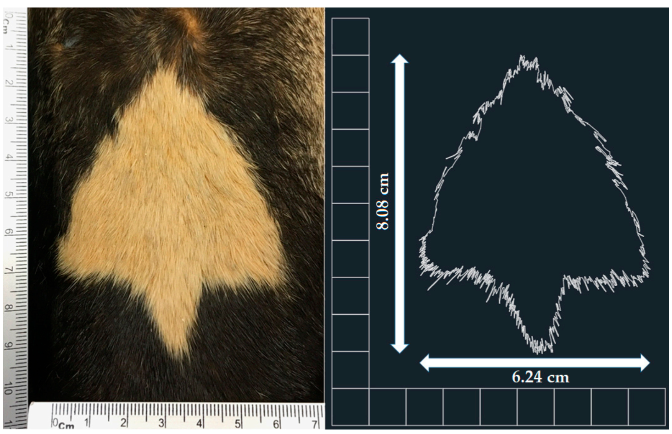
We made a review of the zoological collections of the American continent that could contain specimens of *Eira barbara*, and we contacted the curators to request permission to access their collections. Subsequently we visited the collections that had the largest number of specimens, and the Mexican collections that granted their authorization to examine the specimens. We recorded the collection information available for each specimen, and grouped each specimen by country of collection.

We photographed the throat patch of each of the specimens at a consistent distance (10 cm; Figure 2a), with a ruler visible to allow setting of the correct scale in the photographs taken. We analyzed the images using AutoCAD software (version 2016), in which the outline of each throat patch was delineated. To identify the length of the patch we measured the distance between the top vertical vertex and the lower vertical side, we obtained the width of each throat patch by measuring the maximum distance between the opposing horizontal vertices (Figure 2b). Finally, we obtained the area and perimeter of each patch.

Because shape is a difficult parameter to quantify concisely in a metric [25], we used a Shape Index to characterize throat patch shapes, with calculations based on the relationship between the area and perimeter of a polygon, which facilitates the understanding of a factor at the morphological and functional level [26]. We used the modification of the Patton's Index [27] made by McGarigal and Marks [25] using the formula:

$$\text{Shape} = p_i/2\sqrt{\pi \cdot a_i}$$

where p_i is the perimeter (m) of the patch i, and a_i is the area (m^2) of the patch i, the formula can be read as: shape equals patch perimeter (m) divided by the square root of patch area (m^2), adjusted by a constant to adjust for a circular standard. Thus, although patches may possess very different shapes, they may have identical areas and perimeters and shape indexes. For this reason, this shape index is best considered as a measure of overall shape complexity that compares the complexity of a patch shape to a standard shape. In the vector version of FRAGSTATS (version 2.0, McGarigal and Marks [25]), patch shape is evaluated with a circular standard, with the index referenced as a minimum (1) for circular patches and increasing as patches become increasingly noncircular [25].



(**a**) (**b**)

Figure 2. (**a**) Original photograph; and (**b**) Digitized contour of the throat patch from a museum specimen of *Eira barbara*.

A Wild Population Case Study

To determine the usefulness of potential identification criteria in wild populations, we analyzed independent photographic events of *Eira barbara* obtained in the Peruvian Amazon between April and September of 2008. These photographs were the product of a survey designed to estimate density of *Leopardus pardalis* [28] in which 23 camera stations were established, each with two Reconyx RC-55 (Holmern, WI, USA) digital infrared trail cameras placed in lowland tropical rainforest. The sampling effort was of 3068 camera-nights, and the stations formed a polygon of 22 km^2. Cameras were set to take three photos per trigger on the "rapidfire" setting, which allows approximately one photo to be taken per second. The photographs obtained from *Eira barbara* separated by 24-h cycles were considered as independent events. Photographs were reviewed in which the position of the organism allowed observation of the throat patch and the images were grouped according to the angle of observation: (a) frontal catches, (b) left side capture and (c) right side capture. Individual identification was attempted for all photographs showing any angle of the throat patch, yet additional characteristics including the presence of testes, ear shape, and overall coat coloration were used to confirm identifications when necessary.

3. Results

A total of 275 museum specimens of *Eira barbara* were available for examination; 15 specimens belonged to six zoological collections of Mexico, 103 records belonged to the Division of Mammals of the National Museum of Natural History of the Smithsonian Institution, and 157 specimens were from the zoological collection of the American Museum of Natural History of the United States (Table 2).

Table 2. Reviewed Zoological Collections and number of specimens of *Eira barbara* examined, including details about the status of reviewed specimens.

Country	Collections	Number of Specimens	Specimens with Throat Patch	Specimens without Throat Patch	Analyzed Throat Patch	Incomplete Specimens **
Mexico	Colección Nacional de Mamíferos (CNMA).	2	2	0	2	0
	Colección Mastozoológica del Zoológico Miguel Álvarez del Toro (ZOOMAT).	3	3	0	3	0
	Colección de Mamíferos del Instituto de Investigaciones Biológicas de la Universidad Veracruzana (IBB-UV).	1	1	0	1	0
	Laboratorio de Mastozoología de la División Académica de Ciencias Biológicas de la Universidad Juárez Autónoma de Tabasco (DACBIOL-UJAT).	1	1 *	0	0	0
	Colección Mastozoológica de El Colegio de la Frontera Sur (ECOSUR).	4	4	0	4	0
	Colección Mastozoológica del Centro de Estudios en Desarrollo Sustentable y Aprovechamiento de la Vida Silvestre de la Universidad Autónoma de Campeche (CEDESU-UAC).	4	3	1	3	0
United States	The Division of Mammals of the National Museum of Natural History (NMNH), Smithsonian Institution.	103	74	14	24	15
	Mammalogy Collection of the American Museum of Natural History (AMNH).	157	133	15	36	8
	Total	275	222	30	73	23

* = The characteristics of the specimen did not allow analysis of the form of the throat patch; ** = The skin of the specimen is incomplete and/or the gular area is absent.

The records of the 275 specimens of *Eira barbara* were grouped from the country where they were collected; ten records from Zoo specimens (unknown origin) were grouped in the category named Zoo. Among the analyzed specimens, we found eight specimens whose phenotypic characteristics do not match the description of any taxonomic group currently recognized; these specimens have a white or yellow pelage over all the body with a black snout. They were not included in our detailed analysis because two specimens had a stitched throat patch, and of the remaining six specimens, three had no throat patch and three others were incomplete. The specimens studied were classified into different categories (Figure 3).

Figure 3. Type of specimens found in different Zoological Collections. (**a**) Specimens with entire throat patch (n = 73); (**b**) Specimen with entire throat patch that extends through neck, shoulder and back (n = 8); (**c**) Specimen with entire throat patch obscured (n = 8); (**d**) Specimen with throat patch cut during preservation (n = 83); (**e**) Specimen with stitched throat patch (n = 27); (**f**) Specimen with incomplete throat patch (n = 23); (**g**) Specimens without throat patch (n = 30); and, (**h**) Incomplete specimens (n = 23).

Of the 275 specimens examined, 222 specimens of *Eira barbara* had a throat patch yet only 81 patches were complete. Eight of these 81 samples were excluded because the throat patch extended through the neck, shoulder and back; in these cases the throat patches did not have a limit (Figure 3b) and were impossible to measure. Therefore, only 73 throat patches were used to characterize morphological measurements and the shape index (Tables 3 and A1).

Table 3. Country of origin (in latitudinal order, north to south) of the specimens of *Eira barbara* examined in the Zoological Collections and their throat patch status.

Country	Specimens with Throat Patch	Specimens without Throat Patch	Incomplete Specimens	Total	Number of Measured Throat Patches
Mexico	25	5	1	31	17
Guatemala	7	0	0	7	4
Honduras	2	0	0	2	2
El Salvador	1	0	0	1	0
Nicaragua	3 *	5	1	9	0
Costa Rica	9	4	0	13	4
Panama	20	9	13	42	8
Colombia	34	0	1	35	15
Venezuela	17	4	0	21	4
Trinidad and Tobago	1	0	0	1	1
Guyana	13	3	3	19	1
Brazil	27	0	0	27	6
Ecuador	15	0	2	17	4
Peru	27	0	0	27	2
Bolivia	11	0	0	11	2
Paraguay	1	0	0	1	1
Argentina	1	0	0	1	1
Zoo **	8	0	2	10	1
Total	222	30	23	275	73

* = Throat patches cut during preservation; ** = Specimens of unknown geographical origin.

The contours of the throat patches examined were an irregular polygon form, which differed in the number of sides and vertices that composed them. As a result, all the throat patches lacked an axis of symmetry.

The morphological measurements of the 73 throat patches differed in the length, width, area, and perimeter that occupy each patch. The length values ranged from 0.96 to 14.70 cm (throat patches S50 and S27 respectively, Table A1) with a mean length of (6.03 ± 3.03 cm). The average width of the 73 analyzed patches was (4.31 ± 1.98 cm) with the values ranging from 0.58 to 8.38 cm (patches A1 and S17 respectively, Table A1). There was a significant positive correlation (p = 0.76) between the length and width values of the 73 patches (Figure 4).

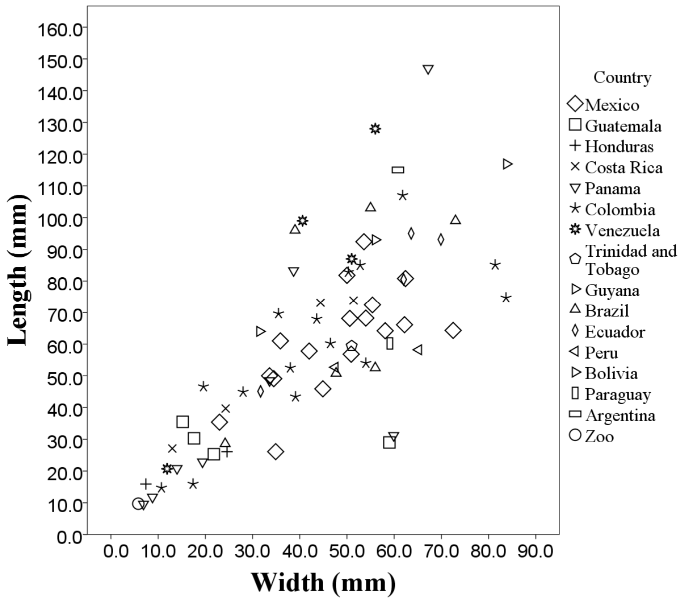


Figure 4. Dispersion of the values of length and width of the 73 throat patches examined of *Eira barbara*. $y = 1.04 + 1.16 \times x$.

The area of the throat patches varied between 0.15 cm^2 and 49.90 cm^2 (A1 and S27 respectively, Table A1) with an average area of (13.76 ± 11.18 cm^2). The perimeter values ranged from 9.28 to 441.98 cm (patches A1 and A2, Table A1) and the average was (143.14 ± 92.41 cm).

Analyzing morphological measurements of throat patches of specimens grouped by country of origin, the averages of the measures indicated that the longest throat patches belonged to specimens collected in Venezuela (8.36 ± 4.53 cm) and the smallest to specimens collected in Honduras (2.10 ± 0.72 cm). This situation was repeated with the measures of perimeter (205.63 ± 118.73 cm and 29.15 ± 21.93 cm respectively). The patches with the largest values of width and area corresponded to specimens collected in Ecuador (5.68 ± 1.70 cm and 21.80 ± 11.54 cm^2 respectively) and the smallest corresponded to specimens collected in Honduras, (1.60 ± 1.21 cm and 1.22 ± 0.98 cm^2 respectively, Table 4).

When plotting the values of the morphological measurements of the throat patches grouped by country of origin, geographic variation in the values of length, width, area and perimeter are evident (Figures 5–8). These data, taken along with clear differences in patch shape demonstrate large amounts of variation in patch characteristics both within and among countries (Figure A2).

The 73 values of the shape index ranged from 5.29 to 20.70 (minimum and maximum respectively, Table A1), indicating that the throat patches have an irregular non-circular shape (Figure 9).

Table 4. Values of the morphological measurements of 73 throat patches of *Eira barbara* collected in different countries. Highest and lowest values in each column are shown in bold.

Country of Origin	Mean Length (cm)	Mean Width (cm)	Mean Area (cm^2)	Mean Perimeter (cm)
Mexico (*n* = 17)	6.12 ± 1.67	4.81 ± 1.28	14.70 ± 6.82	133.40 ± 50.16
Guatemala (*n* = 4)	3.00 ± 0.42	2.84 ± 2.05	4.23 ± 4.06	51.71 ± 31.11
Honduras (*n* = 2)	**2.10 ± 0.72**	**1.60 ± 1.21**	**1.22 ± 0.98**	**29.15 ± 21.93**
Costa Rica (*n* = 4)	5.34 ± 2.36	3.32 ± 1.77	7.89 ± 7.27	103.29 ± 70.43
Panama (*n* = 8)	4.68 ± 4.70	3.10 ± 2.30	9.50 ± 16.67	90.26 ± 70.61
Colombia (*n* = 15)	6.02 ± 2.55	4.41 ± 2.12	13.49 ± 10.59	149.86 ± 90.77
Venezuela (*n* = 4)	**8.36 ± 4.53**	3.98 ± 1.97	17.37 ± 11.15	**205.63 ± 118.73**
Trinidad and Tobago (*n* = 1)	5.94 *	5.10 *	16.19 *	79.25 *
Guyana (*n* = 1)	11.69 *	8.38 *	45.91 *	307.26 *
Brazil (*n* = 6)	7.16 ± 3.15	4.91 ± 1.65	17.68 ± 10.48	203.50 ± 109.91
Ecuador (*n* = 4)	7.84 ± 2.31	**5.68 ± 1.70**	**21.80 ± 11.54**	183.73 ± 56.07
Peru (*n* = 2)	5.54 ± 0.38	5.63 ± 1.25	11.75 ± 0.75	155.38 ± 31.95
Bolivia (*n* = 2)	7.85 ± 2.05	4.37 ± 1.73	12.08 ± 8.71	172.12 ± 64.41
Paraguay (*n* = 1)	6.02 *	5.91 *	16.09 *	261.88 *
Argentina (*n* = 1)	11.50 *	6.08 *	36.30 *	441.98 *
Zoo (*n* = 1)	0.97 *	0.58 *	0.15 *	9.28 *

* The data correspond to a single specimen; the values do not have mean or standard deviation.

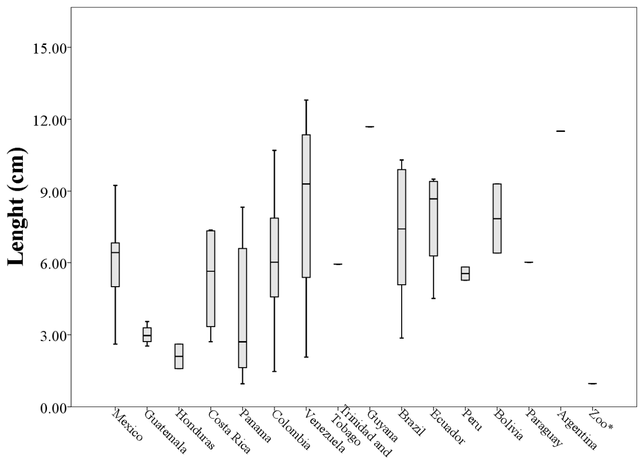


Figure 5. Variation of the length measures (cm) of the throats patches from 73 analyzed museum specimens of *Eira barbara*. * = Specimen of unknown geographical origin.

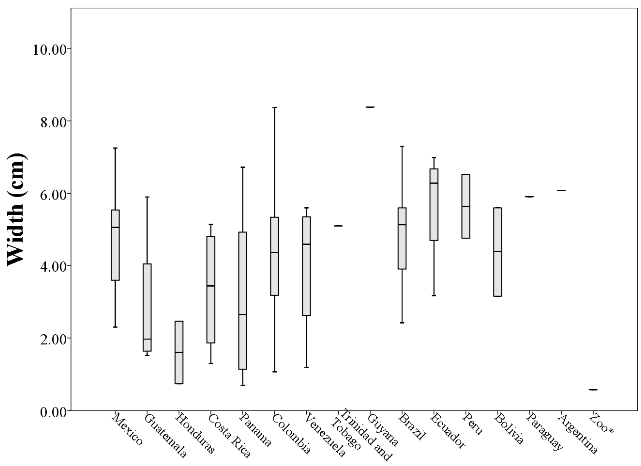


Figure 6. Variation of the width (cm) of the throats patches from 73 analyzed museum specimens of *Eira barbara*. * = Specimen of unknown geographical origin.

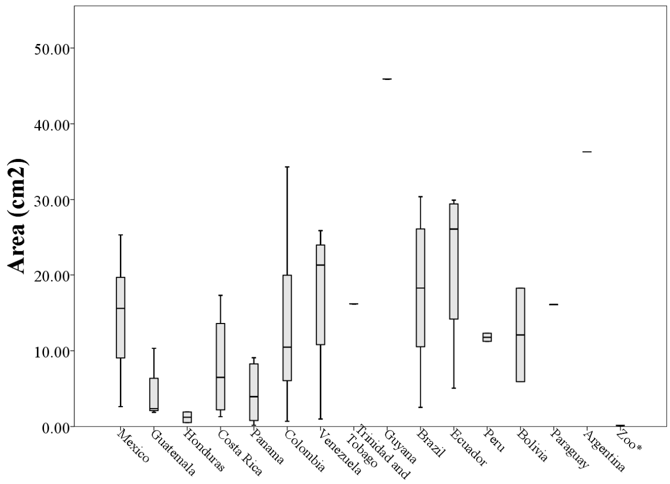


Figure 7. Variation of the area (cm^2) of the throats patches from 73 analyzed museum specimens of *Eira barbara*.* = Specimen of unknown geographical origin.

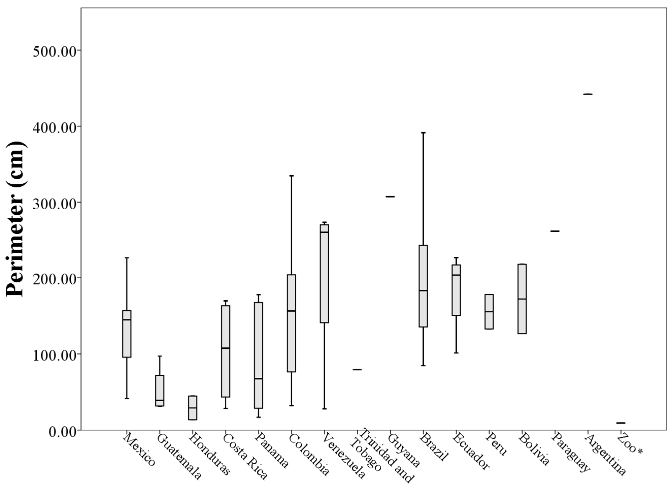


Figure 8. Variation of the perimeter (cm) of the throats patches from 73 analyzed museum specimens of *Eira barbara*. * = Specimen of unknown geographical origin.

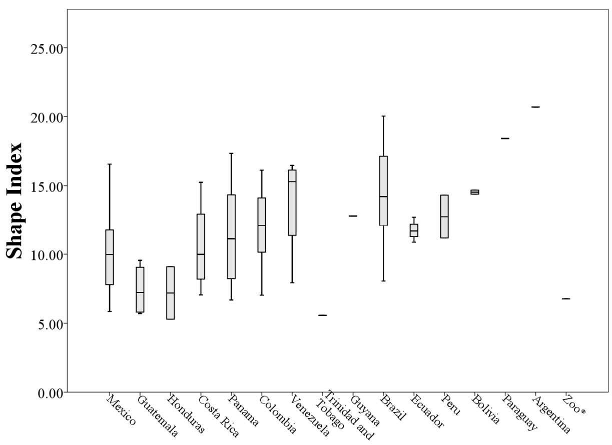


Figure 9. Variation of the shape index values of the throats patches from 73 analyzed museum specimens of *Eira barbara*. * = Specimen of unknown geographical origin.

A Wild Population Case Study

We registered 35 independent photographic events with *Eira barbara* in the Peruvian Amazon. In 19 events (54.0%) a clear image was obtained of the throat patch, which was subsequently used to identify individuals. For all 19 of these events, we were able to assign an individual to the event. In total, nine different individuals were identified: four males and five animals of indeterminate sex (Figures 10 and A3). Two individuals were photographed on different dates; individual B eight times and individual F four different times. Both of these individuals were recaptured only in the same camera-station. The other seven individuals were photographed only on a single occasion (Table 5). In two independent photographic events more than one individual was pictured; in one event two tayras were pictured and another included three in the same photograph.

Figure 10. Comparison of the throat patch of the nine (**a**–**i**) uniquely identifiable individuals. Note that both the frontal (**a**–**d**) and lateral images (**e**–**i**) can be used to differentiate among individuals. Note: The pictures were taken with camera traps during 2008, producing low resolution photographs. Some tayras were photographed in motion, for that reason some photographs are not in focus.

In the photographs where the view is frontal (Figure 10, individuals a–d) it is observed that the contour and size (the space occupied by the patch in the gular area of the animal) of the four throat patches were different from each other. For the remaining individuals, only lateral views of the left (Figure 10, individuals e–g) or the right side (Figure 10, individuals h,i) were available and individual identification was still possible. However in some cases, particularly with individuals showing only lateral patch views, and where photo angles across different photo events were substantially different (e.g., Figure 10e–g), additional characteristics, such as coat color variation and ear shape, were critical in confirming final identifications. Differential coat coloration between the neck and body was seen in 77.7% of the individuals (e.g., Figure 10e).

Table 5. Photographic events obtained of *Eira barbara* across 3068 camera-nights from 23 camera stations in the Peruvian Amazon in 2008. Also shown is the photographic capture record of the nine unique individuals identified from throat patch size, shape and location.

Observations	Months						Total
	April	May	June	July	August	September	
Number of independent photographic events	5	14	8	3	3	2	35
Capture events of males	1	10	5	2	1	1	20
Capture events of females	-	-	-	-	-	-	-
Capture events of unknown sex	5 *	4	5 *	1	2	1	18
Total capture events of tayras	6	14	10	3	3	2	38
Number of tayras without visible throat patch **	5	2	4	1	3	2	17
Number of tayras with visible throat patch	1	12	6	2	-	-	21
Number of identified tayras	1	12	4	2	-	-	19
Identified individuals							
a—unknown sex	-	1	-	-	-	-	1
b—male ***	-	6	1	1	-	-	8
c—unknown sex	-	-	1	-	-	-	1
d—male ***	-	-	1	-	-	-	1
e—unknown sex	-	1	-	-	-	-	1
f—male ***	-	2	1	1	-	-	4
g—unknown sex	-	1	-	-	-	-	1
h—unknown sex	1	-	-	-	-	-	1
i—male ***	-	1	-	-	-	-	1

* = An event included more than one tayra individual; ** = The throat patch is not observed because the photo took the back of the organism or the animal is far from the camera; *** = The penis and/or testicles of the individuals were observed.

Some museum specimens were not included in our detailed analysis because the throat patch were incomplete or artificially matched (i.e., stitched), and the coat color had particular characteristics which made them stand out from the others. In the case of the subspecies *Eira barbara poliocephala* the throat patch extends to the shoulders and back. In the specimens we examined it was evident that the form of this character also differs between organisms in this group (Figure 11a). It was observed that this character has an asymmetrical outline, and therefore has a different form in left and right lateral planes (Figure 11b).

Presley [14] pointed out that a yellow morph of *E. barbara* (Figure 12a) is relatively common in Guyana, and the eight specimens we found with this characteristics were all collected in Guyana. The throat patch was present in two of the eight examined specimens (Figure 12b), in the remaining six specimens, three had no throat patch (Figure 12c) and three others were incomplete.

(**a**) (**b**)

Figure 11. (**a**) Specimens of *E. b. poliocephala*, the throat patch extends through one or both shoulders. In the last two cases, the throat patches do not connect with the back patch; (**b**) Live specimen of *E. b. poliocephala* (Villafañe-Trujillo®), the throat patch extends through shoulders and back, the shape of the patch is different in each flank: right side (upper image) and left side (lower image).

(**a**) (**b**) (**c**)

Figure 12. (**a**) Specimen of *Eira barbara* with yellow and white pelage, record obtained in Guyana (Evi Paemelaere and Esteban Payan, Panthera®); (**b**) Yellow and white specimens, each one has a throat patch; (**c**) Yellow and white specimens without throat patches.

4. Discussion

Quantitative measurements of 73 throat patches have demonstrated that there is sufficient variation in the shape and size of each gular spot is unique in *Eira barbara*, this character can be used to identify tayras on an individual level. Analysis of camera trap photos from a Peruvian Amazon population has demonstrated that it is possible to individually identify tayras with this non-invasive method. The individual identification of tayras using the throat patch can be applied throughout the tayra range and for all the coat color variation in the species, including the white/yellow morphs and those with disruptive coat color.

The descriptions of the subspecies recognized by Cabrera [15] and Hall [16] reflect the phenotypic variability of *Eira barbara* through their geographical distribution. These descriptions are based on an arbitrary and subjective analysis of qualitative characters as opposed to genetic analysis. According to Avise and Ball [29], the subspecies designation should be made based on concordant distributions of multiple independent (genetic) traits. Research conducted by Ruiz-García et al. [17] was focused on generating a phylogenetic reconstruction between *Potos flavus* and *Eira barbara*. They analyzed biological samples of 68 specimens collected in South America and grouped them according to the five recognized subspecies in that region (*barbara*, *sinuensis*, *peruana*, *madeirensis* and *poliocephala*) according to Cabrera [15] and Hall [16]. Molecular results suggest that in South America there are only two subspecies of *Eira barbara*: *barbara* (formed by groups *barbara*, *peruana*, *sinuensis* and *madeirensis*) and *poliocephala*. Consequently, the subspecies of *Eira barbara* currently recognized are four: *senex*, *inserta* (the result of phenotypic descriptions), *barbara* and *poliocephala* (the result of phylogenetic analysis).

Due to the lack of information concerning the coat color variation (regardless of patch characteristics) of *Eira barbara* throughout its area of distribution, we recommend a more comprehensive review of the available zoological collections of the world to generate detailed descriptions of the different existing phenotypes and maps of the distribution of each one. It is also necessary to perform the analysis of mitochondrial DNA of *mtCyt-b* and *mtNADH-5* of specimens collected in Central America with the aim of completing the investigation of Ruiz-García et al. [17], and to identify if the populations of *Eira barbara* present from Mexico to Panama correspond to the subspecies distributed in South America (*Eira barbara barbara*) or if they comprise unique subspecies.

The specimens examined in this research were collected through almost all the area of distribution of the species, and 80.7% (222 of 275) of the examined specimens had a throat patch. However, 30 specimens (10.9%) examined did not have this character, and these were not melanic or albino organisms. Five (1.8%) were collected in Mexico, five in Nicaragua (1.8%), four in Costa Rica (1.4%), nine in Panama (3.2%), four in Venezuela (1.4%) and three in Guyana (1.0%). These results demonstrates that the absence of the throat patch is not restricted to a single population; this condition occurs throughout the northern half of the species range. Regardless, the presence of a clear throat patch in more than 80.0% of examined specimens indicates that this feature will typically be available for individual identification in field populations.

In the case of *Eira barbara*, the literature describes atypical coat coloration [30,31]. Krumbiegel [32] argues that the cases of albinism and melanism are most common in *Eira barbara* than in any other species of mustelid. The lack of a throat patch may be a recurrent genetic mutation in the coloration of the coat similar to that taking place in melanism, albinism or leucism, which occurs in a small percentage of the population [33,34]. These genetic alterations have not been studied in *Eira*, but have been investigated in different mammalian species [24,35–37].

Some species of animals have some unique external characteristic which makes the identification of individuals feasible [38]. The results of this research show that the form (geometric information that results from removing the effects of position, scale and rotation of an object, [39]) and size of the patch on the throat is a distinctive character in every organism of *Eira barbara*. This feature serves as a point of individual reference that allows the identification and differentiation of organisms of *Eira barbara* that have a throat patch. Specific patterns in the coat of an animal are unique and do not change over time [8]. In the case of *Eira barbara*, theoretically, the size of the throat patch will increase proportionally until the animal reaches adult size (this occurs at six months of age, [14]).

Previous research that focused on the individual identification of mustelids (e.g., Magoun et al. [12], Harrison [10] and Sirén et al. [13]) has been based on visual and subjective analysis of the obtained photographic records. Our research was based on the analysis of different quantitative and morphological characteristics of throat patches, which showed that the throat patch is a unique characteristic among individuals, and that it can be used as a basis for the individual identification of wild animals. Ours is the first to combine analysis of camera trap photos with quantitative measurements from a range of museum specimens across the species' range. This allows us to present conclusions on the potential feasibility of camera trap-based field studies throughout the tayra distribution.

A point in common our work and some previous investigations is that the individual identification is only possible when the photographic record of the animal is in a specific position, which allows detailed observation of the distinctive pattern in the pelage. In the case of *Gulo gulo* [12] and *Martes americana* [13] individual identification is only possible if the front of the gular area is photographed (ventral view), whereas in the case of *Taxidea taxus* [10] it is only necessary to obtain photographs of any side of the head in lateral view. Our results for *Eira barbara* show that individual identification is possible with photographs showing the animal's gular area either with a front (ventral view) or side (lateral view). While a clear ventral view allows unambiguous identification from a single clear photograph, the lateral views require both sides to be photographed for unambiguous identification. In addition, the utility of lateral views is somewhat dependent on the angle of the photograph, and some body positions can obscure the throat patch to varying degrees. This is not the case with individuals of the subspecies *Eira barbara poliocephala*, where the throat patch extends over the shoulders and back, and where any lateral view will provide identifiable characteristics for that side. Field studies in Guyana, where the white/yellow morph appears to be common will face additional challenges where our limited sample size indicates the absence of a throat patch may be more common and throat patches, when present, may be more challenging to distinguish from camera trap photographs.

It could be difficult to differentiate individuals if only one side of the tayra is photographed. While it is possible to compare photographs of the same anatomical side of the animal, individual identification could be complicated when comparing different sides, as is the case with jaguars or other individually identifiable species [40]. Given the non-symmetric forms of the patches, we would recommend that camera trap surveys aimed at estimating tayra populations include two cameras at each station as recommended for other species. In instances where only one camera per station is available, some additional options can improve the chances of unambiguous individual identification. First, the use of additional characteristics such as presence or absence of testicles, coat color variation, and shape of the ears, tail and body can certainly aid identification, and these factors were helpful in the identification of numerous individuals in our Peru field case study. Give this, camera setups that increase the amount of time the individual spends in front of the camera, and the chances that the animal will show clear views throat patch will improve one's ability to discriminate individuals with certainty. A range of commercial carnivore lures for example, are likely to at least slow the movement of this species and increase the number of angles from which the animal is photographed. In our field study, tayra reacted strongly to a proprietary carnivore lure (Weaver's Cat Call) and spent significant time investigated a scented stake placed in front of a subset of locations. Previous researchers have also designed custom bait stations which require individuals to expose their gular area to the camera while accessing the bait (e.g., Magoun et al. [12] and Sirén et al. [13]).

Newer spatially explicit capture-recapture (SECR) models designed to estimate density require a reasonable number of individuals to be captured on multiple occasions to allow unbiased estimation of capture probability [41]. While there is no specific guidance on absolute lower thresholds, the nine individuals identified here is likely near the minimum number of individuals required for SECR models. Based on our field study and others, capture rates (independent photo events per 100 camera-nights) for tayra vary widely (this study: 1.14; Campeche, Mexico: 0.67 (Á. J. Villafañe-Trujillo, unpublished data); Iguacu National Park, Brazil: 0.40, [42]) and are typically similar or below capture rates for jaguar in the same areas (this study, [43,44]). Estimation of jaguar densities using camera traps, while common, has been challenging to implement without bias due to low capture rates and large jaguar home ranges [45]. Given that capture rates of tayra are unlikely to be higher than those seen for jaguars, estimation of tayra density from camera surveys is likely to face similar challenges in accumulating enough individuals over a reasonably closed study period. Because our tayra capture rates appear to be at the higher end of those reported, our camera effort (3068 camera-nights) should be seen as a minimum required to accrue sufficient tayra captures, and in some areas twice this value may be necessary. There is some indication that tayra may be more likely to be captured off trails [44], and so future studies may consider this option to further increase capture rates. SECR studies also require that a large percentage of captured individuals be captured at multiple camera stations to allow estimation of an animal movement parameter [41]. As a result, field studies aiming to use SECR to estimate density should aim for a camera spacing that attempts to find a compromise between maximizing the number of individuals captured (i.e., maximizing the size of the study area and capture probability), and maximizing spatial recaptures of individuals (i.e., minimizing camera spacing; [41,45,46]). In this study, cameras were spaced on average 1.1 km apart, and none of the captured tayra were photographed at multiple camera stations, potentially suggesting that tayra in this region have relatively small ranges and that in general, spacing should be substantially less than 1km to ensure spatial recaptures of individuals.

5. Conclusions

This is the most comprehensive study of the coat morphology of this species to date. Throat patches were present in more than 80.0% of examined specimens (100% south of Peru). Using variation in morphological measurements and shape index values, we have demonstrated that the shape and size of every throat patch is a unique character in each specimen of *Eira barbara*. This information sets a precedent for the species, and demonstrates that the identification criteria presented here could be used to identify organisms of wild populations as in the cases of *Gulo gulo* [12], *Martes americana* [13] and *Taxidea taxus* [10]. The proposed identification criterion is applicable across the full distribution of *Eira barbara* and for all phenotypic variations described in the literature, and can be applied through non-invasive camera-based surveys to generate local population estimates for the species.

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Author Contributions: This study was co-designed and implemented by Álvaro José Villafañe-Trujillo as part of his Ph.D. thesis at the Universidad Autónoma de Querétaro, Mexico. Carlos Alberto López-González, his advisor, assisted with study design and manuscript writing. Joseph M. Kolowski designed and led the camera-trap design and field efforts during 2008, and assisted with manuscript writing.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

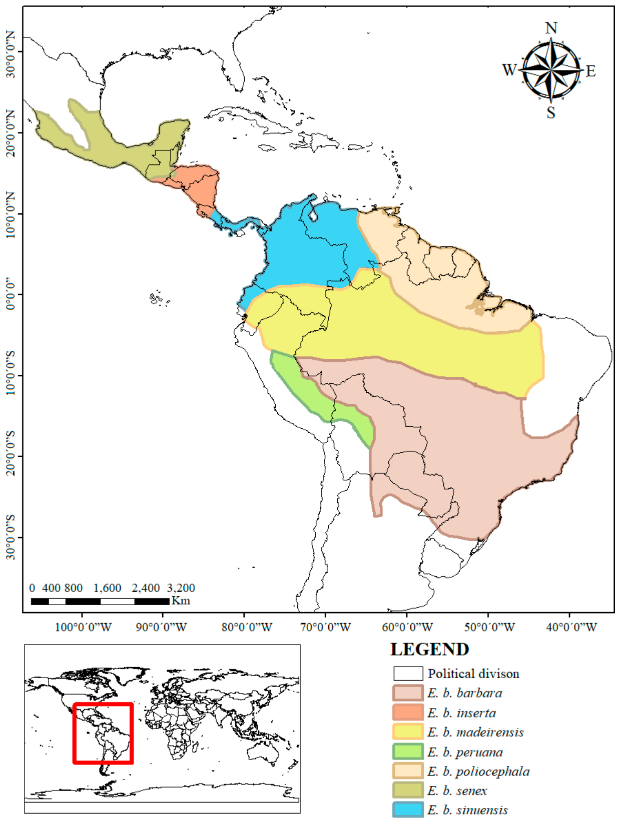

Figure A1. Geographic distribution of *Eira barbara*. The map corresponds to the data proposed by Cabrera 1958 and Hall 1981 (map modified from Presley [14]).

Table A1. Measures of the throat patches of 73 different museum specimens of *Eira barbara*.

Location	Name * of the Specimen in the Collection	Code	Length (cm)	Width (cm)	Area (cm^2)	Perimeter (cm)	Shape Index	Number in Collection
Zoo	Tayra barbara **	A1	0.97	0.58	0.15	9.28	6.76	6856/5516
Argentina	*Eira barbara barbara*	A2	11.5	6.08	36.3	441.98	20.70	185,325
Brazil	*Tayra barbara* **	A3	9.6	3.9	22.5	135.46	8.06	133,958
Brazil	*Tayra barbara* **	A4	5.25	5.6	14.03	227.41	17.13	133,952
Brazil	*Tayra barbara* **	A5	10.3	5.5	26.13	243.13	13.42	133,955
Paraguay	*Tayra barbara galina* **	A7	6.02	5.91	16.09	261.88	18.42	36,507
Honduras	*Tayra barbara inserta* **	A8	1.59	0.74	0.53	13.64	5.29	123,271
Honduras	*Tayra barbara inserta* **	A9	2.61	2.46	1.92	44.66	9.09	128,127
Brazil	*Tayra barbara barbara* **	A13	5.08	4.77	10.53	138.99	12.09	37,479
Bolivia	*Eira barbara*	A15	6.4	3.15	5.92	126.57	14.68	38,810
Bolivia	*Tayra barbara madeirensis* **	A16	9.3	5.6	18.25	217.67	14.38	40,838
Trinidad and Tobago	*Tayra barbara trinitatis* **	A17	5.94	5.1	16.19	79.25	5.56	7543–5937
Colombia	*Tayra barbara* **	A18	5.4	5.4	14.57	95.12	7.03	134,947
Colombia	*Tayra barbara barbara* **	A19	10.7	6.18	32.77	303.29	14.95	37,366
Ecuador	*Eira barbara*	A24	9.31	6.99	29.93	226.44	11.68	182,953
Brazil	*Tayra barbara* **	A26	9.9	7.3	30.38	391.45	20.04	133,953
Venezuela	*Tayra barbara barbara* **	A37	8.7	5.1	21.98	273.71	16.47	30,202
Venezuela	*Tayra barbara* **	A38	12.8	5.6	25.91	266.83	14.79	16,937
Venezuela	*Tayra barbara* **	A39	9.9	4.06	20.62	254.03	15.79	16,938
Mexico	*Tayra barbara senex* **	A45	5	3.36	9.05	146.26	13.72	17,254
Colombia	*Tayra barbara* **	A46	1.47	1.07	0.69	32.19	10.93	37,799
Colombia	*Tayra barbara* **	A47	5.25	3.8	7.75	156.42	15.85	37,800
Costa Rica	*Tayra barbara biologiae* **	A48	2.71	1.3	1.3	28.47	7.05	24,444
Ecuador	*Tayra barbara senilis* **	A50	9.5	6.36	28.94	207.24	10.87	36,589
Brazil	TAYRA	A54	2.86	2.42	2.53	84.56	15.00	36,230
Colombia	*Tayra barbara irara* **	A67	8.51	8.14	23.13	206.21	12.10	14,630
Colombia	*Tayra barbara irara* **	A69	8.28	5.03	19.12	207.98	13.42	14,860
Colombia	*Tayra barbara irara* **	A70	4.34	3.91	8.47	104.11	10.09	14,861
Colombia	*Tayra barbara irara* **	A72	4.49	2.8	4.35	74.62	10.10	15,473
Colombia	*Tayra barbara irara* **	A73	6.02	4.65	10.47	165.2	14.41	15,471
Colombia	*Tayra barbara irara* **	A77	1.59	1.74	1.2	39.57	10.19	23,485
Colombia	*Tayra barbara* **	A85	6.96	3.55	12.66	174.13	13.81	14,224
Colombia	*Tayra barbara barbara* **	A87	7.47	8.37	34.32	334.7	16.12	76,747
Colombia	*Tayra barbara barbara* **	A88	8.5	5.28	20.81	201.66	12.47	76,748
Peru	*Eira barbara*	A114	5.27	4.75	11.24	132.79	11.18	230,838
Colombia	*Tayra barbara barbara* **	A138	4.66	1.96	3.67	74.78	11.01	32,669
Colombia	*Eira barbara biologiae* **	S2	6.79	4.36	8.49	78.04	7.56	281,467
Costa Rica	*Tayra barbara biologiae* **	S3	7.38	5.14	17.31	156.75	10.63	8411–38,483
Costa Rica	*Tayra barbara biologiae* **	S4	3.97	2.43	3.11	58.32	9.33	11,375
Costa Rica	*Tayra barbara biologiae* **	S5	7.31	4.44	9.87	169.65	15.24	12,875
Panama	*Tayra barbara biologiae* **	S10	1.18	0.88	0.43	27.94	12.02	171,081
Ecuador	*Eira barbara biologiae* **	S11	4.51	3.17	5.06	101.3	12.71	104,547
Peru	*Eira barbara peruana*	S12	5.82	6.52	12.31	177.98	14.31	149,015
Ecuador	*Taya barbara biologiae* **	S14	8.05	6.2	23.29	199.95	11.69	104,546
Guyana	*Tayra barbara poliocephala* **	S17	11.69	8.38	45.91	307.26	12.80	172,995
Mexico	*Eira barbara senex*	S21	5.78	4.2	11.69	127.81	10.55	181,265

Table A1. *Cont.*

Location	Name * of the Specimen in the Collection	Code	Length (cm)	Width (cm)	Area (cm^2)	Perimeter (cm)	Shape Index	Number in Collection
Guatemala	*Eira barbara senex*	S22	2.9	5.9	10.32	97.2	8.54	61,276
Guatemala	*Eira barbara senex*	S23	2.53	2.18	1.88	46.39	9.55	287,480
Mexico	*Eira barbara senex*	S24	6.43	7.25	23.24	117.37	6.87	13,070
Mexico	*Eira barbara senex*	S25	4.59	4.49	8.41	170.18	16.56	100,447
Panama	*Tayra barbara* **	S27	14.7	6.72	49.9	167.15	6.68	15,423
Panama	*Tayra barbara biologiae* **	S38	8.33	3.87	9.08	177.84	16.65	297,961
Panama	*Tayra barbara biologiae* **	S41	4.85	3.36	6.03	92.99	10.69	297,962
Panama	*Eira barbara biologiae* **	S42	3.12	5.99	7.46	167.86	17.34	310,671
Panama	*Eira barbara biologiae* **	S43	2.08	1.4	1.15	29.32	7.71	310,673
Panama	*Eira barbara biologiae* **	S44	2.29	1.94	1.85	42.13	8.74	334,556
Panama	*Eira barbara biologiae* **	S50	0.96	0.69	0.17	16.88	11.55	335,772
Guatemala	*Eira barbara senex*	S68	3.55	1.52	2.32	31.92	5.91	287,482
Venezuela	*Eira barbara poliocephala*	S69	2.07	1.19	0.99	27.95	7.93	296,625
Guatemala	*Eira barbara senex*	S70	3.03	1.76	2.41	31.35	5.70	287,481
Mexico	*Eira barbara*	MX 1	5.68	5.09	12.09	144.87	11.76	CNMA-4160
Mexico	*Eira barbara senex*	MX 2	6.82	5.4	19.48	95.58	6.11	CNMA-188
Mexico	*Eira barbara*	MX 3	8.18	5	19.68	226.21	14.39	ZOOMAT-0311-828
Mexico	*Eira barbara*	MX 4	6.61	6.22	21.23	162.84	9.97	ZOOMAT-726
Mexico	*Eira barbara*	MX 5	6.1	3.59	12.33	86.05	6.91	ZOOMAT-0303-123
Mexico	*Eira barbara senex*	MX 6	8.08	6.24	25.35	141.93	7.95	IIB-UV-3451
Mexico	*Eira barbara*	MX 7	7.24	5.54	18.14	215.82	14.30	ECOSUR-5431
Mexico	*Eira barbara senex*	MX 8	9.24	5.36	20.41	147.81	9.23	ECOSUR-5552
Mexico	*Eira barbara senex*	MX 9	2.61	3.49	4.04	41.7	5.85	ECOSUR-1170
Mexico	*Eira barbara senex*	MX 10	3.54	2.3	2.63	59.35	10.33	ECOSUR-2585
Mexico	*Eira barbara*	MX 11	6.42	5.81	19.09	151.47	9.78	CEDESU–UAC-836
Mexico	*Eira barbara*	MX 12	4.91	3.45	7.51	75.66	7.79	CEDESU–UAC-604
Mexico	*Eira barbara*	MX 13	6.81	5.06	15.59	156.94	11.22	CEDESU–UAC–without number

The letters indicate the name of the Zoological Collection to which the specimen belongs: A = AMNH; S = NMNH–Smithsonian Institution and MX = Zoological Collections of Mexico; CNMA = Colección Nacional de Mamíferos; ZOOMAT = Zoológico Miguel Álvarez del Toro; IBB-UV = Instituto de Investigaciones Biológicas de la Universidad Veracruzana; ECOSUR = El Colegio de la Frontera Sur; CEDESU–UAC = Centro de Estudios en Desarrollo Sustentable y Aprovechamiento de la Vida Silvestre de la Universidad Autónoma de Campeche. * = This is the name given by the original collectors to the specimens; ** = This name is no longer used.

Figure A2. *Cont.*

Figure A2. Photographs of the 73 museum specimens of *Eira barbara* examined, showing the differences in shape and size of the throat patches. The letters indicate the name of the Zoological Collection to which the specimen belongs: A = AMNH; S = NMNH–Smithsonian Institution, and MX = Zoological Collections of Mexico.

Figure A3. *Cont.*

Figure A3. Records of *Eira barbara* in the Peruvian Amazon. The letter corresponds to each identified animal (**b**, **d**, **f** and **i** = males; **a**, **c**, **e**, **g** and **h**, = animals of unknown sex). The records of the same animal correspond to different dates. The circles in the images pointed at the penis and/or testicles of the animal.

References

1. González-Romero, A. Cinco métodos sencillos para estimar el tamaño de las poblaciones de fauna silvestre. In *Manual de Técnicas Para el Estudio de la Fauna*; Tessaro, G., González, C.L., Eds.; Universidad Autónoma de Querétaro: Santiago de Querétaro, Mexico, 2011; p. 377. ISBN 07-7740-98-8.
2. Páez, E.; Lezama, M. Estimaciones de abundancia por marca-recaptura utilizando radiotelemetría. *Encuentro* **1998**, *46*, 16–24.
3. Otis, D.L.; Burnham, K.P.; White, G.C.; Anderson, D.R. Statistical inference from capture data on closed animal populations. *Wildl. Monogr.* **1978**, *62*, 3–135.

4. Borchers, D.L.; Efford, M.G. Spatially Explicit Maximum Likelihood Methods for Capture-Recapture Studies. *Biometrics* **2008**, *64*, 377–385. [CrossRef] [PubMed]
5. Kirkland, G.L. Guidelines for the Capture, Handling, and Care of Mammals as Approved by the American Society of Mammalogists. *J. Mammal.* **1998**, *79*, 1416–1431. [CrossRef]
6. Testé, E.T.; Denis, D. Bases para la fotoidentificación de las cebras (*Equus burchellii*) del Parque Zoológico Nacional de Cuba/Basis for the photoidentification of zebras (*Equus burchellii*) in the National Zoological Garden of Cuba. *Rev. Cuba. Cienc. Biol.* **2013**, *2*, 50–68.
7. Burton, A.C.; Neilson, E.; Moreira, D.; Ladle, A.; Steenweg, R.; Fisher, J.T.; Bayne, E.; Boutin, S. REVIEW: Wildlife camera trapping: A review and recommendations for linking surveys to ecological processes. *J. Appl. Ecol.* **2015**, *52*, 675–685. [CrossRef]
8. Hammond, P.S.; Mizroch, S.A.; Donovan, G.P. *Individual Recognition of Cetaceans: Use of Photo-Identification and Other Techniques to Estimate Population Parameters: Report of the International Whaling Commission*; Special Issue; International Whaling Commission: Cambridge, UK, 1990; ISBN 906975-23-7.
9. Harmsen, B.J.; Foster, R.J.; Sanchez, E.; Gutierrez-González, C.E.; Silver, S.C.; Ostro, L.E.T.; Kelly, M.J.; Kay, E.; Quigley, H. Long term monitoring of jaguars in the Cockscomb Basin Wildlife Sanctuary, Belize, Implications for camera trap studies of carnivores. *PLoS ONE* **2017**, *12*, e0179505. [CrossRef] [PubMed]
10. Harrison, R.L. Noninvasive Identification of Individual American Badgers by Features of Their Dorsal Head Stripes. *West. N. Am. Nat.* **2016**, *76*, 259–261. [CrossRef]
11. Trujillo, F.; Portocarrero, M.; Gómez, C. *Plan de Manejo y Conservación de Especies Amenazadas en la Reserva de Biósfera El Tuparro: Delfines de rio, Manatíes, Nutrias, Jaguares y Tortugas del Género Podocnemis. Proyecto Pijiwi Orinoko (Fundación Omacha-Fundación Horizonte Verde)*; Forest Conservation Agreement: Bogotá, Colombia, 2008; ISBN 58-97826-5-1.
12. Magoun, A.J.; Valkenburg, P.; Lowell, R.E. *Habitat Associations and Movement Patterns of Reproductive Female Wolverines (Gulo Gulo Luscus) on the Southeast Alaska Mainland*; Wildlife Research Annual Progress Report; Department of Fish and Game: Petersburg, AK, USA, 2008.
13. Sirén, A.; Pekins, P.; Abdu, P.; Ducey, M. Identification and Density Estimation of American Martens (Martes americana) Using a Novel Camera-Trap Method. *Diversity* **2016**, *8*, 3. [CrossRef]
14. Presley, S.J. *Eira barbara*. Mammalian Species. *Mamm. Species* **2000**, *636*, 1–6. [CrossRef]
15. Cabrera, A. Catálogo de los mamíferos de América del Sur. Revista del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia". *J. Mammal.* **1958**, *4*, 1–307.
16. Hall, E.R. *The Mammals of North America*, 2nd ed.; John Wiley & Sons, Inc.: New York, NY, USA, 1981.
17. Ruiz-García, M.; Lichilín-Ortiz, N.; Jaramillo, M.F. Molecular phylogenetics of two Neotropical carnivores, Potos flavus (Procyonidae) and *Eira barbara* (Mustelidae): No clear existence of putative morphological subspecies. *Mol. Popul. Genet. Evol. Biol. Biol. Conserv. Neotrop. Carniv.* **2013**, *32*, 37–84.
18. Camargo, C.C.; Ferrari, S.F. Interactions between tayras (*Eira barbara*) and red-handed howlers (*Alouatta belzebul*) in eastern Amazonia. *Primates* **2007**, *48*, 147–150. [CrossRef] [PubMed]
19. López González, C.A.; Lara, A.; Daniel, R. Noteworthy record of the Tayra (Carnivora: Mustelidae: *Eira barbara*) in the Sierra Gorda biosphere reserve, Querétaro, México. *West. N. Am. Nat.* **2007**, *67*, 150–151. [CrossRef]
20. Ramírez Bravo, O.E. Nuevos registros de tayra (*Eira barbara* Linnaeus 1758) en Puebla, centro de México. *Acta Zool. Mex.* **2011**, *27*, 883–886.
21. Pérez-Irineo, G.; Santos-Moreno, A. Diversidad de mamíferos terrestres de talla grande y media de una selva subcaducifolia del noreste de Oaxaca, México. *Rev. Mex. Biodivers.* **2012**, *83*, 164–169.
22. González-Maya, J.F.; Zárrate-Charry, D.; Vela-Vargas, I.M.; Jiménez-Alvarado, J.S.; Gómez-Hoyos, D. Activity patterns of Tayra Eira barbara populations from Costa Rica and Colombia: Evidence of seasonal effects Patrones de actividad de poblaciones de la Tayra *Eira barbara* en Costa Rica y Colombia: Evidencia de efectos estacionales. *Rev. Biodivers. Neotrop.* **2015**, *5*, 96–104. [CrossRef]
23. Reyes-Puig, C.P.; Ríos-Alvear, G.D.; Reyes-Puig, J.P. Notable ampliación del rango altitudinal de *Eira barbara* Cabeza de Mate (Mammalia: Mustelidae). *ACI Av. En Cienc. E Ing.* **2015**, *7*, B098–B102.
24. García, J.J.M.; García, A.D.M.; Cruz, J.M.C. Registros del tayra (*Eira barbara*) en el estado de Hidalgo, México. *Rev. Mex. Mastozool. Nueva Época* **2016**, *6*, 24–28.
25. McGarigal, K.; Marks, B.J. *Spatial Pattern Analysis Program for Quantifying Landscape Structure*; General Technical Report PNW-GTR-351; USA Department of Agriculture, Forest Service Pacific Northwest Research Station: Portland, OR, USA, 1994.

26. Vila Subirós, J.; Varga Linde, D.; Llausàs i Pascual, A.; Ribas Palom, A. Conceptos y métodos fundamentales en ecología del paisaje (landscape ecology). Una interpretación desde la geografía. *Copyr. Doc. Anàl. Geogr.* **2006**, *48*, 151–166.
27. Patton, D.R. A diversity index for quantifying habitat "edge". *Wildl. Soc. Bull. (1973–2006)* **1975**, *3*, 171–173.
28. Kolowski, J.M.; Alonso, A. Density and activity patterns of ocelots (*Leopardus pardalis*) in northern Peru and the impact of oil exploration activities. *Biol. Conserv.* **2010**, *143*, 917–925. [CrossRef]
29. Avise, J.C.; Ball, R.M. Principles of genealogical concordance in species concepts and biological taxonomy. *Oxf. Surv. Evol. Biol.* **1990**, *7*, 45–67.
30. Tortato, F.R.; Althoff, S.L. Variações na coloração de iraras (*Eira barbara* Linnaeus, 1758-Carnivora, Mustelidae) da Reserva Biológica Estadual do Sassafrás, Santa Catarina, sul do Brasil. *Biota Neotrop.* **2007**, *7*, 365–367. [CrossRef]
31. Sobroza, T.V.; Gonçalves, A.L.; dos Santos, L.S. Predation attempt and abnormal coat coloration of the tayra (*Eira barbara*) in the Brazilian Central Amazon. Stud. *Neotrop. Fauna Environ.* **2016**, *51*, 231–234. [CrossRef]
32. Krumbiegel, I. *Die Säugetiere der Südamerika-Expeditionen Prof. Dr. Kriegs*; Zoologischer Anzeiger: Leipzig, Germany, 1942; Volume 139, pp. 81–96.
33. Caro, T.M. The adaptive significance of coloration in mammals. *BioScience* **2005**, *55*, 125–136. [CrossRef]
34. Abreu, M.S.L.; Machado, R.; Barbieri, F.; Freitas, N.S.; Oliveira, L.R. Anomalous colour in Neotropical mammals: A review with new records for *Didelphis* sp. (Didelphidae, Didelphimorphia) and Arctocephalus australis (Otariidae, Carnivora). *Braz. J. Biol.* **2013**, *73*, 185–194. [CrossRef] [PubMed]
35. Kettlewell, H.B.D. *The Evolution of Melanism: The Study of a Recurring Necessity*; Clarendon Press: New York, NY, USA, 1973; ISBN 198573708.
36. Majerus, M.E.N. *Melanism: Evolution in Action*; Oxford University Press: New York, NY, USA, 1998; ISBN 198549826.
37. Elosegi, M.M.; Rubines, J.; Ruíz, A. Hallazgo e identificación molecular de un ejemplar de garduña, Martes foina (Erxleben, 1777) con coloración atípica en Ezkurra (Navarra). *Galemys* **2006**, *18*, 23–26.
38. Chehrsimin, T. Enhanced Methods for Saimaa Ringed Seal Identification. Master's Thesis, Lappeenranta University of Technology School of Engineering Science, Lappeenranta, Finland, 2015.
39. Kendall, D.G. The Diffusion of Shape. *Adv. Appl. Probab.* **1977**, *9*, 428–430. [CrossRef]
40. Silver, S.C.; Ostro, L.E.T.; Marsh, L.K.; Maffei, L.; Noss, A.J.; Kelly, M.J.; Wallace, R.B.; Gómez, H.; Ayala, G. The use of camera traps for estimating jaguar Panthera onca abundance and density using capture/recapture analysis. *Oryx* **2004**, *38*. [CrossRef]
41. Royle, J.A.; Chandler, R.B.; Sollmann, R.; Gardner, B. (Eds.) *Spatial Capture-Recapture*; Elsevier: Amsterdam, The Netherlands, 2014; p. 568.; ISBN 978-0-12-405939-9.
42. Xavier da Silva, M.; Paviolo, A.; Tambosi, L.R.; Pardini, R. Effectiveness of Protected Areas for biodiversity conservation: Mammal occupancy patterns in the Iguaçu National Park, Brazil. *J. Nat. Conserv.* **2018**, *41*, 51–62. [CrossRef]
43. Tobler, M.W.; Carrillo-Percastegui, S.E.; Leite Pitman, R.; Mares, R.; Powell, G. An evaluation of camera traps for inventorying large- and medium-sized terrestrial rainforest mammals. *Anim. Conserv.* **2008**, *11*, 169–178. [CrossRef]
44. Tobler, M.W.; Zúñiga Hartley, A.; Carrillo-Percastegui, S.E.; Powell, G.V.N. Spatiotemporal hierarchical modelling of species richness and occupancy using camera trap data. *J. Appl. Ecol.* **2015**, *52*, 413–421. [CrossRef]
45. Tobler, M.W.; Powell, G.V.N. Estimating jaguar densities with camera traps: Problems with current designs and recommendations for future studies. *Biol. Conserv.* **2013**, *159*, 109–118. [CrossRef]
46. Sollmann, R.; Gardner, B.; Belant, J.L. How Does Spatial Study Design Influence Density Estimates from Spatial Capture-Recapture Models? *PLoS ONE* **2012**, *7*, e34575. [CrossRef] [PubMed]