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Short Note

Who am I? Testing I3S Contour on the facial mask of the Western polecat (*Mustela putorius*)

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Abstract

Individual recognition of wild animals is a fundamental tool to acquire information about the structure and dynamics of animal populations. Recently, individual identification from camera trapping has been successfully applied to Capture-Mark-Recapture (CMR) studies in various taxa. We collected 281 photos of 48 specimens of Western Polecat (*Mustela putorius*) from various Italian Museums to test the capabilities of I3S contour software to automatically recognize different individuals from their facial mask. After selecting 52 high quality pictures from different specimens, we obtained a 100% success rate of correct individual identification. This suggested that both facial mask pattern and automatic identification might be successfully applied to the study of this highly elusive species through camera trapping.

Individual recognition of wild animals is a fundamental tool for research on population size, structure and density, as well as on animal movements and behaviour (Cruickshank and Schmidt, 2017; Ngoprasert et al., 2012; Fischhoff et al., 2007; Karanth et al., 2006; Williams et al., 2002). This is especially relevant in population studies based on Capture-Mark-Recapture (CMR) methods, where individual marking allows applications of more accurate algorithms to estimate population sizes (see for example Davis et al., 2020). There are various methods of individual marking of mammals, such as ear tags, permanent and semi-permanent markings, GPS and VHF radio collars, microchips, PIT tags, and non-invasive genotype sampling (Kubasiewicz et al., 2017; Sikes and Gannon, 2011; Kéry et al., 2010; Rondinini et al., 2006; Morley, 2002).

The advent of digital photography and camera trapping provided a new opportunity for individual identification in a variety of animals, including invertebrates (Díaz-Calafat et al., 2018; Caci et al., 2013), fish (Hook et al., 2019; chaves et al., 2016; Van Tienhoven et al., 2007), amphibians (Renet et al., 2019; Sannolo et al., 2016; Caorsi et al., 2012), reptiles (Calmanovici et al., 2018; Sacchi et al., 2010; Reisser et al., 2008), and mammals (Crouse et al., 2017; Reinhart et al., 2013; Ngoprasert et al., 2012; Hiby et al., 2009; Kelly, 2001). Unlike other techniques, photographic identification is more cost effective and less invasive and stressful for animals (Mendoza et al., 2011), especially for elusive and rare mammals (Theimer et al., 2017). Many mammals have frontal coloration and chest marks that serve as intraspecific and interspecific signals (Caro and Allen, 2017; Caro et al., 2017). Among mammals, many mustelids show individual patterns of colour marking on throat and/or face that could be used for individual recognition (Loy, 2018; Macdonald et al., 2017; Müller, 2002).

The Western polecat *Mustela putorius* is suffering a rapid decline in some parts of Europe (Croose et al., 2018). The drivers of this decline are poorly understood but may include habitat alteration, changes in prey availability, poisoning and killing (Croose et al., 2018), hybridisation with the domestic ferret (Costa et al., 2013), road-kills (Barrientos

Figure 1 – An example of the start points of each contour and the point of semiautomatic contour identification of the facial mask on the Western polecat. The specimen in this picture was provided by MUSE - Museo delle Scienze, Trento.

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Table 1 – Details of specimens and photos of Western polecats used in I3S contour software and analysis.

Museum	N° specimens	N° photos
Collezione Teriologica del Museo Civico di Scienze Naturali di Bergamo	9	49
Museo Civico di Storia Naturale Carmagnola	4	31
Museo Geologico "G. Cortesi", Castell'Arquato	2	10
Collezione Altobello del Museo di Zoologia dell'Università di Bologna	11	68
MUSE – Museo delle Scienze, Trento	10	60
Museo Civico di Storia Naturale di Ferrara	5	21
Museo di Storia Naturale ed archeologia di Montebelluna	1	10
Civico Museo Insubrico di Storia Naturale, Induno Olona	1	7
Museo di Storia Naturale dell'Università di Pavia	5	25
Total	48	281

and Bolonio, 2009), and competition with American mink (Barrientos, 2015). The species is listed in annex V of the Habitat Directive (42/93/EC), thus requiring periodical monitoring and reporting of its conservation and distribution trends. However, this information is very hard to gather, as due to the elusive nature of polecats, capturing them in live traps is challenging. In contrast, polecats are often recorded during camera trapping for wildlife surveys (Salewski and Schmidt, 2019; Ramesh et al., 2017). The colour pattern of the Western polecat is characterized by a facial mask consisting in a dark portion of the fur on a paler/white background that includes the eye and extends until the nose (Fig. 1). As in most mustelids, the facial pattern varies among individuals and its role is still debated (Loy, 2018; Macdonald et al., 2017). Here we tested if I3S Contour (http://www.reijns.com/i3s/), a software designed for photographic identification of cetaceans, could be used for individual facial recognition of polecats, thus helping in designing CMR census for this elusive species. This software allows the researcher to extract an individual's contour using a semi-automatic algorithm, after which, I3S compares this contour against all individuals in the database and shows the most relevant results in a ranked list with score.

We collected 281 photos of 48 stuffed specimens of Western polecats provided by nine Italian museums (Tab. 1). All pictures were taken and provided by the museum curators. We then selected only those pictures showing the facial mask with an angle not greater than 30 degrees, which is requested for a good performance of I3S Contour software (Den Hartog and Reijns, 2011). A further selection was based on image quality and conditions of specimens, keeping only those in which the contours of the facial mask were easily detectable. The final database included 52 pictures, including replicas of 17 individuals photographed at a different angle, to simulate recaptures. On each picture two outlines of the facial mask, each starting from each side of the nose tip, were automatically captured through I3S Contour (Fig 1). The start and end point of each contour were set by the operator. We then compared each contour of the 17 "recaptures" with the 52 pictures included in the database through the semi-automatic algorithm that ends with a list of matching probability scores between the reference and all other specimens. For further detail see Den Hartog and Reijns (2011).

Following Sacchi et al. (2010) and Caci et al. (2013), for each image we calculated the scores of the second image of the same individual (D_{rep}) and the average of the scores of all the images within the database ($D_{population}$). We then used a paired t-test (significance set at p=0.05) to compare D_{rep} vs $D_{population}$. All statistical analyses were performed with R software (R Development Core Team, 2017).

The software provided a good performance for the construction of the contour of the facial mask (Fig. 1).

All 17 replicas of individuals tested ranked in the first position in the list, i.e. showed the lowest scores for the same individual, resulting in a 100% success rate of correct individual identification. That is, for each individual specimen the lowest rank picture was that of the same individual photographed with a different angle, i.e. its "recapture".

The paired t-tests confirmed that the average of D_{rep} scores (mean=89000 $\pm$ 99530) were significantly smaller than the average of $D_{population}$ scores (mean=275007 $\pm$ 318462) (t=-3.26; df=15: p=0.005).

Our results demonstrated that Western polecats could be individually recognized through their facial mask pattern, confirming the high rate of software recognition that was shown by Caci et al. (2013) on a much larger sample size.

The use of facial recognition techniques through software could be a very useful tool to improve population studies on polecats and estimate population abundance and trends. Our results are especially promising

Figure 2 – Examples of "capture" (left), and "recapture" (right) of the same specimen of a Western polecat.

considering the continuing increase and improvement of camera trapping studies (Dorning and Harris, 2019; Ngoprasert et al., 2012).

Nevertheless, we are aware that our high success rate could be related to the strict selection of pictures and the optimal conditions in which the animals were photographed. By contrast, images recorded by camera traps of mobile, wild animals in natural environments are typically lower quality.

In addition, clear photos of the face of wild animals are rarely captured by camera traps. In order to increase the chances of obtaining good quality facial shots of elusive species, scent lures could be applied (Larrucea et al., 2007), and camera traps should be set at an appropriate height and distance to enhance the probability of capturing polecats (Salewski and Schmidt, 2019; Hofmeester et al., 2017).

The high performance of I3S Contour software in individual recognition of polecats from pictures suggests that this technique could be tested and easily extended to other mustelids with individual facial or throat designs such as the Steppe Polecat (*Mustela eversmanii*), the Marbled Polecat (*Vormela peregusna*), or the Giant Otter (*Pteronura brasiliensis*) (Loy, 2018; Macdonald et al., 2017).

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