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CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

Twenty-eighth meeting of the Animals Committee
Tel Aviv (Israel), 30 August-3 September 2015

Interpretation and implementation of the Convention

Species trade and conservation

Reptile sourcing and traceability systems [Decision 16.103, paragraphs b) to d)]

IDENTIFICATION CARRIER FOR A GLOBAL TRACEABILITY INFORMATION SYSTEM FOR REPTILE SKIN

1. This document has been submitted by Italy and Mexico and was prepared by the Responsible Ecosystems Sourcing Platform (RESP) .*

2. At its 16th meeting in Bangkok, the Conference of the Parties adopted Decision 16.103 which directed the Animals Committee to, among other issues:

   b) *examine […] any other relevant available information concerning:*

      i. *existing marking and tracing systems and, where relevant, accompanying certification schemes of all kinds (and not necessarily limited to those currently in use for trade in wild species), which could provide best practices that might be applicable to snakes;*

      ii. *a traceability system to confirm the legal origin of snake skins; and*

      iii. *the economic feasibility of current technologies to implement such a traceability and marking system*;

   c) *advise the Standing Committee on the feasibility of implementing such a traceability system for snakes; and*

   d) *report on the status of this work at the 65th and 66th meetings of the Standing Committee.*

3. As a contribution to the work of the Animals Committee outlined in Decision 16.103, Italy and Mexico have been actively advancing the development a global traceability information system for reptile skins to complement and strengthen the current CITES permitting system related to this trade. This work has been led by RESP – through its International Working Group on Reptile Skins (IWG-RS).

* *The geographical designations employed in this document do not imply the expression of any opinion whatsoever on the part of the CITES Secretariat (or the United Nations Environment Programme) concerning the legal status of any country, territory, or area, or concerning the delimitation of its frontiers or boundaries. The responsibility for the contents of the document rests exclusively with its author.*

4. The system aims to ensure legal, sustainable, stable and continuous supply chains for reptile skins by tracing skins from their origin in the wild or breeding facility up to the final product with controls along the entire supply and regulatory chain.

5. As a first step, the IWG-RS undertook an international consultation process, which involved more than 130 stakeholders. The main findings of this consultation process were documented and analysed by RESP in the document "System requirements for a global traceability information system for reptile skins" which was presented to the 27th Meeting of the Animals Committee of CITES under agenda item 19.4.

6. During 2014, extensive research was undertaken by the IWG-RS and its technical partners in close collaboration with stakeholders in Indonesia, Italy and Mexico on the development of an identification carrier able to withstand the tannery chemical and mechanical operations, as this was identified as the crucial bridge in the value chain.

7. In April 2015, the proof of concept of the identification carrier was validated and the attached Annex provides a report of progress achieved to date and presents the results and main findings of the proof of concept of the identification carrier.

8. The Animals Committee is invited to:

   - Take note of the progress and results presented;

   - Consider the conclusions of the proof of concept and the recommended next steps;

   - Provide comments on the options outlined for the development of a global traceability information system for reptile skins; and

   - Forward the outcome of discussions at this meeting to the Standing Committee for their consideration at their 66th meeting.

INTERNATIONAL WORKING GROUP ON REPTILE SKINS

IDENTIFICATION CARRIER FOR A

GLOBAL TRACEABILITY INFORMATION SYSTEM FOR REPTILE SKINS

Main findings and recommendations

Introduction

1. The International Working Group on Reptile Skins (IWG-RS) of the Responsible Ecosystems Sourcing Platform (RESP) has set a goal to develop, test and implement a global traceability information system for reptile skins and its corresponding databases in a number of pilot countries by the end of 2016.

2. The system aims to ensure legal, sustainable, stable and continuous supply chains for reptile skins by tracing skins from their origin in the wild or breeding facility up to the final product with controls along the entire supply and regulatory chains.

3. This document has been prepared by RESP and summarises the outcomes of work undertaken by the IWG-RS with its technical partners and in collaboration with stakeholders in Indonesia, Italy, Mexico and South Africa as a contribution to the work of the Animals Committee outlined in Decision 16.103.

4. The composition of the IWG-RS is provided in Annex 2. The IWG-RS has worked continuously through virtual meetings and calls using information prepared by the RESP Secretariat and its technical partners and has met three times to assess the advancements of progress and take decisions regarding next steps.

5. This report builds from the document AC27 Doc 19.4 which was presented and discussed at the 27th Meeting of the Animals Committee in Veracruz, Mexico, and considers recommendations for future work provided by the Working Group established by the Committee (AC27 WG4 Doc. 1).

6. During 2014 and the beginning of 2015, the work focused on the development of an identification carrier able to withstand the tannery chemical and mechanical operations, as this was identified as the crucial bridge in the value chain.

7. The requirements considered for the development of the identification carrier included value chain stakeholders demands such as:

   i. To be simple, affordable, sustainable;

   ii. To operate throughout all the supply chain from the raw material to the final product;

   iii. To be secure, tamperproof and resist chemical and mechanical processing;

   iv. To be easy to apply and implement at all production levels;

v. To be capable of distinguishing skins of all reptile species to the amount of 7 - 10 million specimen per species, which is the estimated trade over a period of 10 years;

vi. To offer real-time on-line registration and verification.

Selection of the identification carrier for the proof of concept

8. A number of identification carrier options each with different technologies were analysed and tested. These included labels or tags, RFID devices, patterns of drilled holes using laser technology and biometric identifiers.

9. After analysing these options against a pre-defined set of criteria as shown in the table below, the solution based on biometric systems – which exploits the skin as a unique fingerprint – presented itself as the most conclusive in terms of security, simplicity, mobility, applicability, costs, infrastructure requirements, reliability, and efficiency

Table 1: Assessment of potential identification carriers

Technology	Description	Advantages	Disadvantages
Label	A label with a unique identifier is applied to the skin at the skinnery or slaughterhouse. The label includes security features to prevent counterfeiting.	- The production of the label can be centralised at a secure location and issued by a centralised authority - There is a good margin in the choice of the material, the data format, and the security features. - The label can be attached to the skin at an early point in the supply chain.	- The label can be easily detached and reattached to the skin, thus compromising integrity and anti-counterfeit requirements - The label can be damaged or destroyed during the chemical and mechanical operations at tannery level.
RFID	An RFID is a tag that is applied to the skin. The RFID carries security features to prevent counterfeiting.	- The Production of the RFID can be centralised at a secure location and issued by a centralised authority - The tag can contain a large amount of data and provide additional functionalities - The tag can be attached to the skin at an early point in the supply chain - The tag is able to transmit data wirelessly to a receiver	- The label can be easily detached and reattached to the skin, thus compromising integrity and anti-counterfeit requirements - Costs can be higher than previous solution. To be assessed with respect to industry expectations. - The tag can be damaged or destroyed during the mechanical operations at tannery level.
Marking via holes	An identifier is created on the skin via a manual perforation device at a suitable point along the supply chain	- Relatively low costs - Easy to explain to end-users. Marking process easy to implement - The code production of the holes code can be centralised at a secure location and issued by a centralized authority	- Holes can tear during processing so a reasonably high level of redundancy is needed - The code can be copied unless coupled with another technology - Requires some available space on the skin.
Biometric based on fingerprinting principle	Biometric features of each individual skin are used to create a unique identifier. E.g. scale pattern, design,	- The information is directly connected to the animal at a very early stage of the supply chain	- To be assessed how the tanning process impacts on the biometric features selected (e.g. variability of dimensions and colour

Technology	Description	Advantages	Disadvantages
	etc.	- It can be very difficult to counterfeit - It can be very cost effective - It can be very easy to implement	during the tanning process) - To be assessed if the biometric features are unique and can recognize 7-10 Mio skins per species - Specific software should be developed.

10. Before taking the final decision to focus on the biometric systems for the proof of concept, additional feasibility tests were performed to assess whether it was necessary to use micro or macro image analysis with specific software to uniquely identify reptile skins.

11. The feasibility tests conclusions were that:

    i. With current high resolution phones, macroscopic skin appearance can be used as identifier, as shown in figure 1;

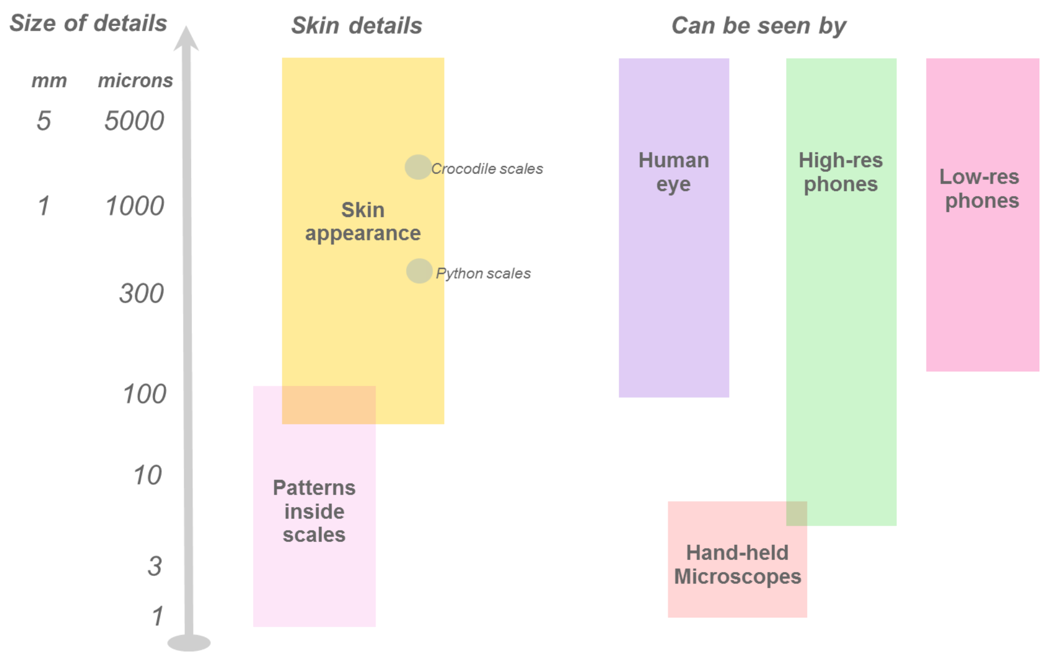
    ii. A 3x3 cm area contains enough biometric data to distinguish singular skins among hundreds of skins;

    iii. Larger areas than 3x3 cm would allow the distinction up to the targeted minimum of 7 million skins, which is to be validated within a larger test set;

    iv. Acquiring the full skin pattern and storing it in a database would allow to identify every single piece of that skin and compare it with and distinguish it from random pieces of other skins;

    v. It is possible to successfully distinguish skins based on their macroscopic appearance.

Figure 1: Potential level of recognition depending on the level of detail



Proof of concept parameters

12. Based on the feasibility test's conclusions, the macroscopic fingerprint was retained as the solution with the highest potential to satisfy all the requirements presented in document [AC27 Doc 19.4](AC27 Doc 19.4).

13. The proof of concept's aim was to prove the ability of the proposed solution to uniquely identify a larger number of skins and, in particular, do this taking into consideration the different appearances of the skins at each stage of supply chain, and to answer the following research questions:

    i. Can skin appearance serve to distinguish 7 – 10 million of skins of each species?

    ii. Does skin appearance bear enough information across the supply chain?

    iii. Can smartphones be used to acquire images?

    iv. Can the whole system be applied in the field and is it affordable?

14. The <u>approach</u> chosen to achieve this was to:

    i. Map all tannery processes and operations that could have an impact on the identification carrier, with the collaboration of Dolmen SpA, Anaconda Srl and Centrorettili SpA;

    ii. Acquire more than 1700 images of raw, tanned and finished python, lizard and crocodile skins for processing and recognition;

    iii. Study smartphones (low to high resolution) used in the field and across supply chain;

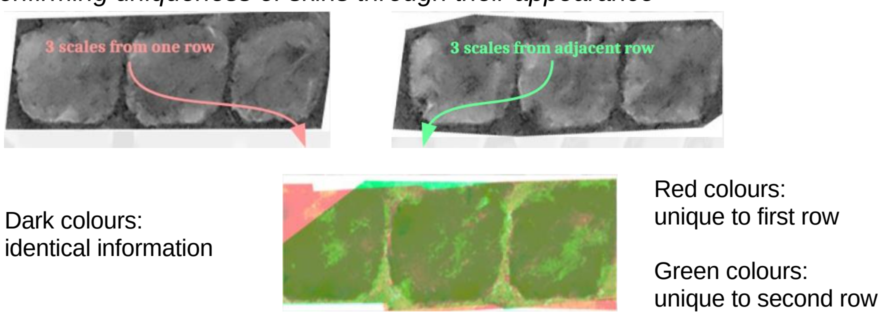
    iv. Review biological aspects.

15 .In parallel, the image acquisition application and algorithms, and pattern recognition algorithms were developed and optimised; and the scale recognition algorithms customised.

<u>Distinguishing skins based on their biometric information</u>

16. A vast amount of tests were undertaken to confirm the uniqueness of skins through their appearance. The figure below illustrates one example that provides the basic blocks that resulted in the composition of the uniqueness of the skin.

Figure 2: Example of confirming uniqueness of skins through their appearance



17. Two adjacent rows of scales of the same skin were analysed where one row of scales was coloured in red (converted to red image) and the other was coloured in green (converted to green image). The two rows were aligned, superimposed and shown as one coloured image where red still corresponds to first row and green to the second.

18. Observations from this and other numerous examples concluded that:

    i. even two adjacent scales of the same skin exhibit differences;

    ii. those differences are quite rich and representative;

    iii. those differences are repeatedly obtained from different images of same skin;

19. Further tests were performed using automatic alignment and analysis with various available algorithms and technologies. The goal was to confirm the use of scales as the reference grid.

20. When scales are used as a reference, the precision of the position of microscopic details can only be measured with respect to the precision of the position of the scales. Initial alignment was sufficiently precise to start working with details seen as differences in Figure 2 above.

21. All above researched differences were analysed with various technologies as to their contribution to the uniqueness and the resilience to various treatments the skin is subject to during its lifespan. The skin uniqueness is thus based on the combination of differences over certain randomly chosen areas of the skin.

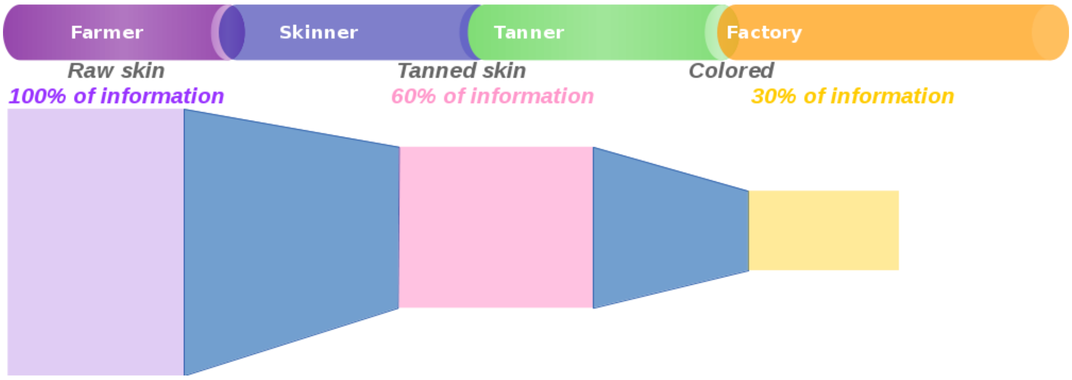
22. Based on the above, a Unique Fingerprint Identifier (UFI) was constructed and linked to certain areas of the skins and the redundant representations of differences present in those areas.

Survival of biometric information throughout the supply chain

23. With the confirmation that the skin appearance can be used to uniquely distinguish skins, the next objective was to estimate the potential change of the skin's uniqueness across the supply chain and determine if the various treatments and transformation processes that the skins are subject to degrade the quality and/or quantity of the biometric information needed to continue distinguishing the skins.

24. Tests in this phase were performed focusing on a set of images of skins acquired before and after the tanning, pigmenting and mechanical processes. The figure below shows the relative step-by-step degradation of biometric information and that about 30% of the information available for the skin uniqueness survives the various skin treatments (chemical and mechanical) throughout the supply chain.

Figure 3: Survival of biometric information throughout the supply chain.



25. Only the biometric information that survives all the stages of the processing can be used for reliable traceability across the whole supply chain. The performed tests demonstrated that at least 30% of information survives and thus establishes the threshold of minimum available information that the system should be able to analyse to confirm the uniqueness of the skin at any point of the supply chain.

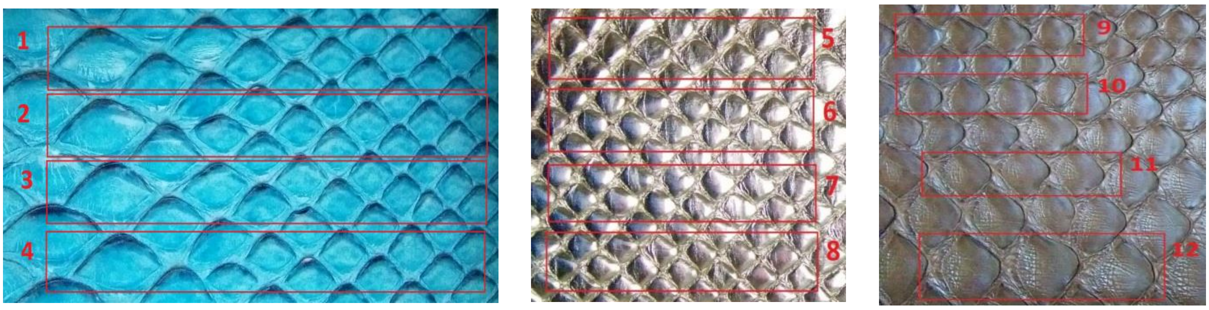
26. This also determines the requirements for the image acquisition application. The algorithm should be able to separate the 30% of the information (that will survive all treatments) from the rest at the beginning of the supply chain. This is also important at the moment before tanning and pigmenting where skin identification should be based on surviving information while discarding temporary information that will disappear.

Estimation of the minimal required surface

27. With the confirmation that enough biometric information survives the entire transformation processes across the supply chain, the next step was to determine the minimum area of the skin needed to obtain the necessary information to uniquely identify the skin at any given point in the supply chain.

28. The first test performed was with pigmented python skins. The figure below illustrates an example where dyed blue, filmed "gold" and pigmented brown skin samples were used. Twelve areas of roughly 1x7cm were captured by the application and each area was given a different identification.

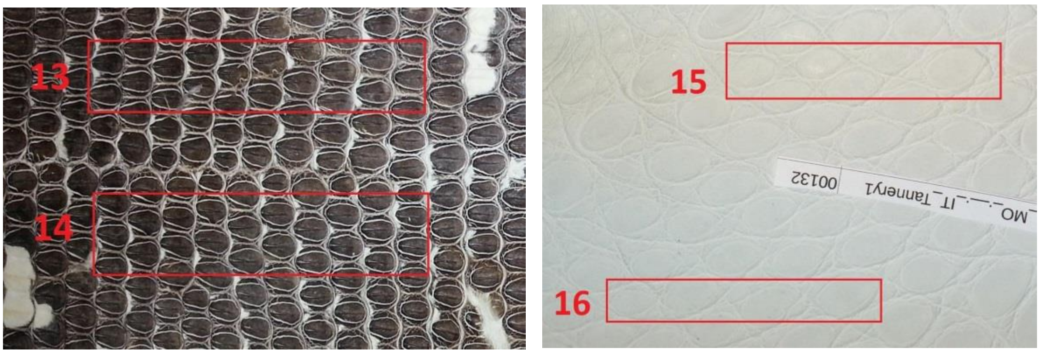
Figure 4. Example of determining minimum required area for recognition of python skins



29. The results of the test were positive as the system correctly identified all of the identifications corresponding to each of the designated skin fragments and rejected unidentified patches.

30. The same method was undertaken with crocodile and lizard skins as shown in the figure below with the same positive results.

Figure 5. Example of determining minimum required area for recognition of crocodilian and lizard skins

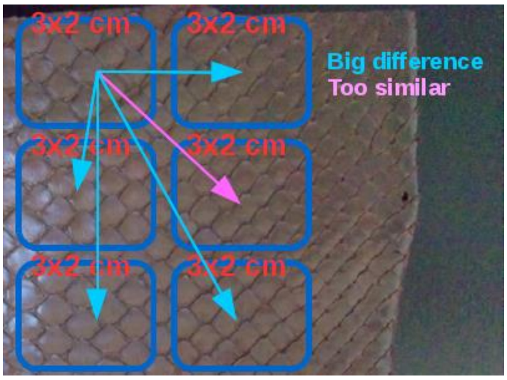


31. Observations from these and numerous other examples concluded that a rather small area (1x7cm) is sufficient to uniquely identify a piece between hundreds of skins so the next step was to determine the minimal required area to distinguishing a very large given number of skins.

32. The extrapolation methodology included several approaches. One of them was to take uniqueness measurements for increasing sizes of areas (1x1cm, 2x2cm, etc.) on available skin samples and compute its representativeness limit in terms of the number of skins.

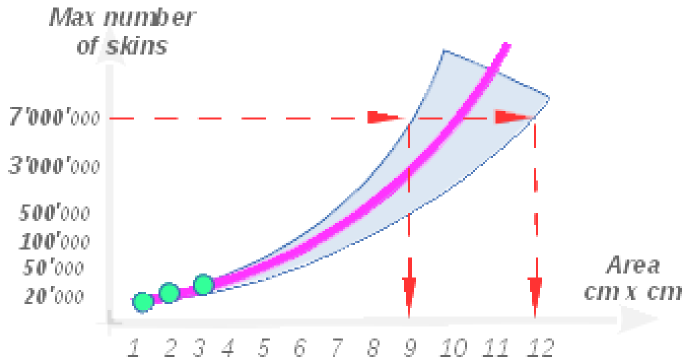
33. For example on the Figure 6 below, 3x2 cm areas were taken and differences in uniqueness between them were calculated. Blue arrows indicate sufficiently big differences, while the magenta arrow indicates risky similarity. This approach allows defining for a given area, the upper limit of skins this area can represent.

Figure 6. Example of how to determine minimum areas for recognition of a given number of skins



34. This estimation of the maximum number of skins that can be represented by a given area was done for increasing surface sizes. For each surface area a maximum number of representable skins were computed. The experimental data is represented by green dots on the graph below.

Graph 1. Calculation of minimum required area for a given number of skins



35. By extrapolating the data with the magenta curve, one can estimate for a target number of skins the minimum area needed to uniquely represent each of them. From the graph, for a target of 7 million of skins, the area between 9x9 cm and 12x12 cm is required.

36. With the positive confirmation of the three assessments presented above, the image acquisition parameters for field testing needed to be determined and confirmed.

<u>Image acquisition</u>

37. Image acquisition with a smartphone is an essential process step to guarantee a minimal required image quality for the reliable detection of a skin's "fingerprint".

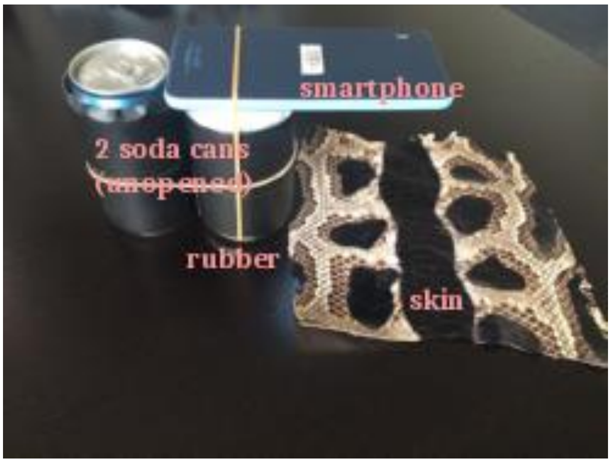
38. Adequate image acquisition needs to be guaranteed in a variety of conditions: from the field through to the production/distribution/verification environments like slaughterhouses, drying facilities, tanneries, customs, and boutiques, among others. Therefore, the image acquisition needs to be simple while reliable to guarantee versatility of the solution while providing the required quality.

39. Image stability and light are the two crucial parameters to set.

40. Stability of the phone's camera with respect to the viewed object is required because autofocusing must occur within one second before the image is taken. If during that time interval the smartphone or object move, the image becomes blurred and fine details essential for obtaining the "fingerprint" cannot be captured. Human hands do not provide for sufficient stability and distance precision, therefore there is the need to use external elements to provide the required stability and to standardise the distance/orientation from which the image needs to be taken.

41. A simple solution illustrated in Figure 7 provides a solution to the requirements of stability and distance. The phone is put on a soda can with its frontal camera pointing downwards. The soda can, being unopened and thus heavy, offers sufficient stability to hold a smartphone in horizontal position. This way the distance from the camera to the skin becomes standard (and corresponds to the ideal case from the technical perspective). The phone is attached to the can with a simple rubber band.

Figure 7: The "SodaCam tripod"

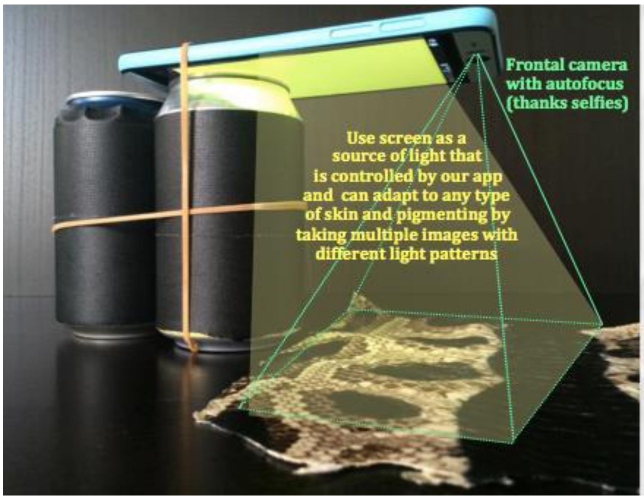


42. Light variations greatly influence the appearance of the objects in the images. Given the large variety of finishes of skins, images will need to be processed and analysed by the system for which the illumination needs to adapt to various surface properties (mirror effect or very dark colour) in order to obtain the best results in each case.

43. Mobile phone flashes/torches were not found to be suitable for correct image acquisition due to the fact that they do not have variations in colour and have limited variation in strength.

44. For this reason, the test results pointed to the use of the frontal camera of the phone as the most adequate method for image acquisition exploiting the phone's screen as the appropriate light source as shown in the figure below.

Figure 3: The use of the frontal camera and screen of the phone for ideal acquisition parameters



45. By using this method, the results concluded that:

    i. The light produced by the phone's screen can be fully controlled by the image acquisition application and adapted to each case;

    ii. A closed-loop is created between the camera and illumination thus requiring the use of only one single device. Depending on what type of skin the camera is viewing, the illumination will be automatically adapted and the image acquired checked for appropriateness;

    iii. The light of the screen is sufficient to illuminate any type of skin.

46. The research determined that the majority of the phones currently being used in the field – even some old models – have frontal cameras. However, in the case when a frontal camera is absent, an alternative method can be applied by using two phones – one for image taking with the back camera and one for illumination.

47. This method requires that also the frontal camera must have sufficient image resolution. Research found that most of the phones that were produced before 2011 do not have an adequate resolution. In this case the two-camera solution alternative explained above could also be used.

48. To validate image acquisition various tests were performed. A wide range of illumination patterns, colours and light strengths were used. In the initial phase of the study approximately 50 test illumination patterns were used. The study narrowed down the number of possible patterns to a dozen. In the final solution the application will be capable of analysing the first images obtained and based on the result of the analysis, re-acquire the images with the ideal pattern and light for the submitted skin.

<u>Additional/ongoing tests</u>

49. A number of additional tests are on-going including the acquisition of skin appearance from pictures of live animals as well as understanding if biological aspects correlated to skin appearance can be determined from the detailed skin representation.

50. It is expected that detailed skin representation will allow having an insight into whether the skin appearance elements are correlated to certain genetic traits such as recognition of males and females.

Conclusions

51. The main conclusion of the work undertaken was that the proof of concept for using a traceability system based on biometric image recognition was achieved.

52. Specific conclusions include:

    i. Biometric image recognition provides a unique affordable identification of at least 7 million skins of any particular reptile species.

    ii. Biometric information acquired through image recognition constitutes a secure, tamper proof, affordable traceability method which is of simple distribution and easy application from the origin up to the final product.

    iii. Skins retain enough information to be distinguished throughout the supply chain, which will be further verified and validated in the pilot phase.

    iv. The proposed system has been proven to be applicable to the entire supply chain up to the final product for both authentication and track & trace, which will be further verified and validated during the pilot phase.

    vi The proposed solution is adaptable and customisable to multiple products.

    vi. The proposed solution is economically viable with no investments required at capture/slaughter level

    vii. Initial results indicate that biological traits can correlate to skin appearance. For example, skin appearance can probably be correlated to genetics: males and females based on image recognition.

Potential recommendations

53. Potential recommendations (and/or support) that the Animals Committee might wish to make to Parties considering the conclusions reached above, might include, where appropriate, some of the issues listed below.

    i. Take note of validation of the proof of concept for using a traceability system for reptile skins based on biometric image recognition;

    ii. Support the development and implementation of a pilot testing phase in a semi controlled commercial environment, to provide fact based information in support of assessing the feasibility of implementing such a traceability system by the Standing Committee and Conference of the Parties;

    iii. Provide inputs to the identification of the code structure and data management system for the pilot testing environment which should be composed of a global hub interfaced with pilot country national systems;

    iv. Provide inputs to the testing and validation of the identification carrier from at least two producing countries to one importing country and the respective customs and regulatory processes.

    v. Engage in and provide inputs to the definition of a set of acceptance criteria agreed with the aim of qualifying and validating the results of the pilot testing phase;

    vi. Support the involvement of their local authorities and industry actors in the further development of the global information system;

vi. Call for funding to be made available from various sources including CITES Parties, development cooperation agencies and industry actors to support the pilot testing of the proposed system.

Composition of the RESP International Working Group on Reptile Skins

The International Working Group on Reptile Skins (IWG-RS) of the Responsible Ecosystems Sourcing Platform (RESP) was established in 2013 by a group of entities from the industry, governments, research institutions and civil society organisations committed to take collective action and leadership towards defining, measuring and promoting the sustainable management of crocodilian, snakes and lizards as a means to contributing to achieving sustainable and inclusive growth that benefit people and nature.

With its current members and partners, the IWG-RS continues to grow and inspire change.

Members of the IWG-RS:

- Agropecuaria Setten, Brazil
- International Leather Bracelets Association (AQC), Switzerland
    - Brasport, Switzerland
    - Camille Fournet, France
    - Interstrap, Switzerland
    - Multicuirs, Switzerland
    - Hirsch Armbänder, Austria
- Burberry, United Kingdom
- Caimanes y Cocodrilos de Chiapas, Mexico
- Cape Cobra, South Africa
- Cocodrilia, Mexico
- Cocodrilos Maya, Mexico
- Colibri de la Antigua, Mexico
- Giorgio Armani, Italy
- Istituto Europe di Design Madrid, Spain
- Italian Tanners' Association (UNIC), Italy
    - Anaconda, Italy
    - Centrorettili, Italy
    - Italrettili, Italy
    - Italven Conceria, Italy
    - Legnotan, Italy
    - Dolmen, Italy
    - Reptilis, Italy
- Küpfer Cuir, Switzerland
- LVMH Group, France
- Mulberry, United Kingdom
- Pure Fashion Lab, Norway
- University of the Arts London, United Kingdom

Technical partners:

- Anteleon Imaging
- SICPA