

Taking Ichnology to the general public: the experience of TERRAGAZE and TERRAGAZE mobile

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SUMMARY - *Taking Ichnology to the general public: the experience of TERRAGAZE and TERRAGAZE mobile* - Ichnology is facing a wall: scientific research is almost isolated from the general public. Surveys demonstrate the meager status of Ichnology: general public ignores the existence of the discipline and the study of traces is unfamiliar even among non-ichnologist scientists. These results are confirmed by the poor resonance of Ichnology in the media: popular-science magazines rarely communicate advances in the field, and few documentaries cover the subject. Ichnology desperately needs to escape from the elitist pages of scientific journals to reach the general public. A broad audience requires new, coherent and engaging methods: interactive media represent successful tools to communicate Ichnology. This article discusses the case study of TERRAGAZE and TERRAGAZE mobile, multimedia systems developed for geological divulgation, with a focus on the ichnological heritage.

RIASSUNTO - *Comunicare l'Icnologia al grande pubblico: l'esperienza di TERRAGAZE e TERRAGAZE mobile* - L'Icnologia sta fronteggiando un muro: la ricerca è quasi del tutto isolata dal grande pubblico. Diversi sondaggi dimostrano infatti l'infelice stato dell'Icnologia: il pubblico ignora l'esistenza di questa disciplina, poco conosciuta anche fra gli scienziati non-icnologi. Queste affermazioni sono confermate dalla scarsa risonanza che l'Icnologia trova nei media, tanto è vero che le riviste scientifiche di divulgazione raramente riportano i progressi in questo campo; inoltre, pochi documentari trattano l'argomento. L'Icnologia necessita di un'alternativa alle riviste scientifiche specialistiche. Il grande pubblico richiede nuovi, avvincenti metodi di comunicazione: ad esempio, i media interattivi sono strumenti adatti a comunicare l'Icnologia. Questo articolo discute i casi di studio di TERRAGAZE e TERRAGAZE mobile, sistemi multimediali interattivi sviluppati per divulgare il patrimonio geologico, con particolare accento a quello icnologico.

Key words: computer vision, virtual reality, interactive kiosks, geotourism, interactivity, Ichnology

Parole chiave: computer vision, realtà virtuale, chioschi interattivi, geoturismo, interattività, Icnologia

1. INTRODUCTION

1.1. *Ichnology, general public and scientific journalism*

"I'm an Ichnologist"

"A what?"

"No shit!"

Greg Betty (2003), *Midnight at the Ichnologist's ball*

Ichnology never gained fame within popular science and education; specifically, invertebrate Ichnology is almost unknown within the general public. Even within the subject area of the Earth Sciences, Ichnology represents one of the less visible disciplines; only dinosaur footprints constitute a remarkable exception. A thick divide separates ichnological research from the general public: large audiences are isolated from Ichnology.

In order to quantify this divide between academia and the public, and, consequently, to determine the degree of pe-

netration of Ichnology, an on-line survey has been carried out. Despite the modest number of answers (315), the results of the poll show a very clear tendency: Ichnology is alien to the general public (Fig. 1).

Why Ichnology has such a marginal role in popular science? An immediate answer: Ichnology is mainly found within scientific journals. There is almost no mention of the discipline in broader-audience press: this fact is demonstrated by figure 2, reporting how many search results are returned for "Ichnology" in scientific press. Ichnology is hardly discernable among the other disciplines of Earth Sciences, while Paleontology, Geophysics, Mineralogy are well represented.

The lack of visibility of Ichnology is more evident when comparing Geology with other disciplines (Fig. 3): even the most prominent branch of Earth Sciences appears minor when compared with the search results for Physics or Biology.

Scientific journalism rarely covers trace fossils: even

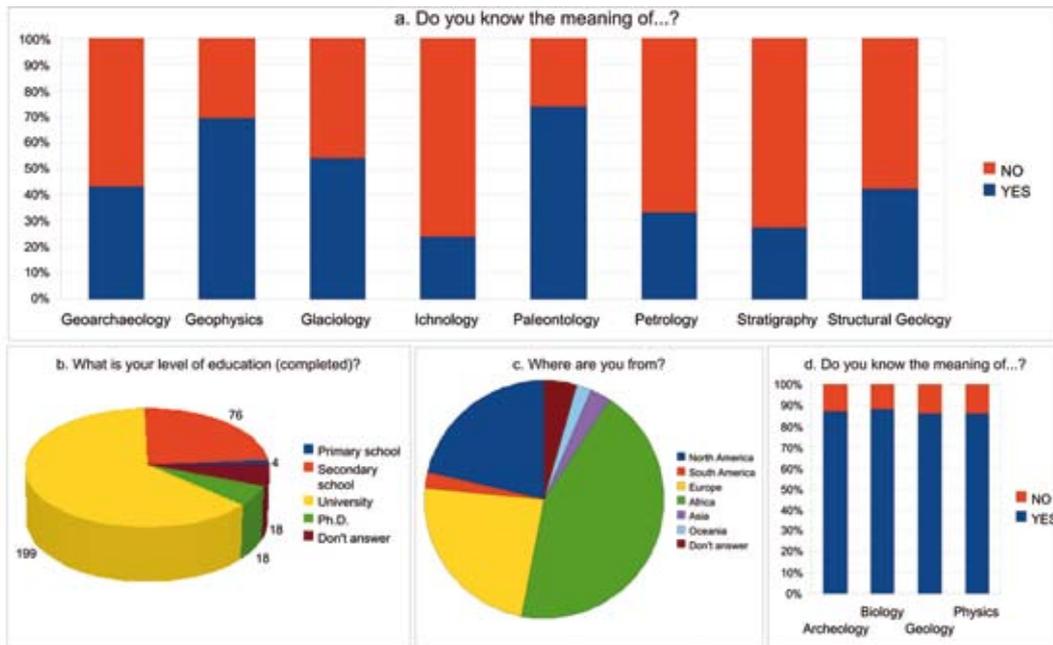


Fig. 1 - Penetration of Ichnology amongst the general public. a. Knowledge of some disciplines of Earth Sciences. The poll received 315 answers, which is a scarce number to describe precisely the general public, but they are enough to trace its tendency. b. Population of the poll: level of education. c. Population of the poll: geographic provenance. d. Population of the poll: knowledge of some of the major branches of science.

Fig. 1 - Diffusione dell'Ichnologia tra il grande pubblico. a. Conoscenza di alcune discipline delle Scienze della Terra. Il sondaggio ha ricevuto 315 risposte, un numero scarso per descrivere il grande pubblico, ma sufficiente per tracciare una tendenza. b. Popolazione del sondaggio: livello di istruzione. c. Popolazione del sondaggio: provenienza geografica. d. Popolazione del sondaggio: conoscenza di alcune delle maggiori branche della scienza.

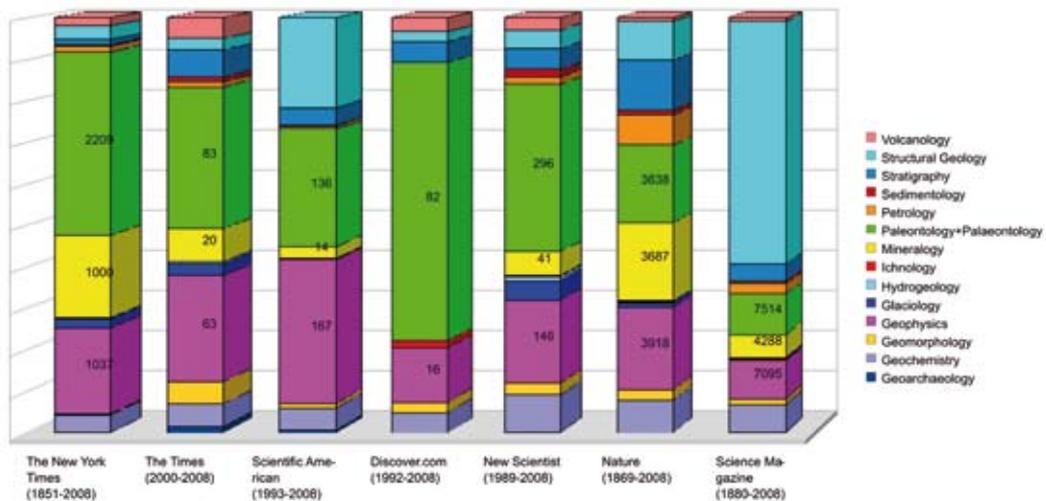


Fig. 2 - The chart shows the frequency of use of the term “Ichnology” within scientific press: Ichnology is cited so rarely that it is difficult to find it among the other disciplines. Different kinds of journals/magazines/papers were searched: news-related papers (*The New York Times*, *The Times*), popular science press (*Scientific American*, *Discover*, *New Scientist*) and technical, non-specialized journals (*Nature*, *Science Magazine*). The online search engine of each journal/magazine has been used to find how many times a certain term (Geoarchaeology, Geochemistry etc) occurs. The chart reports normalized results; only some numerical results are shown for graphic clarity. The search range is reported in brackets; updated as for 28/02/2008.

Fig. 2 - Il grafico mostra la frequenza di utilizzo del termine “Ichnologia” nella stampa scientifica: l'Ichnologia è citata così raramente che è difficile distinguerla tra le altre discipline. Diversi tipi di stampa sono stati sottoposti a ricerca: giornali di attualità (*The New York Times*, *The Times*), divulgazione scientifica (*Scientific American*, *Discover*, *New Scientist*), letteratura scientifica tecnica, non specialistica (*Nature*, *Science Magazine*). È stato impiegato il motore di ricerca di ciascuna rivista/magazine per trovare quante volte ricorra un certo termine. Il grafico riporta valori normalizzati; solo alcuni valori numerici sono indicati espressamente (per chiarezza grafica). Il periodo di ricerca è riportato tra parentesi; aggiornato al 28/02/2008.

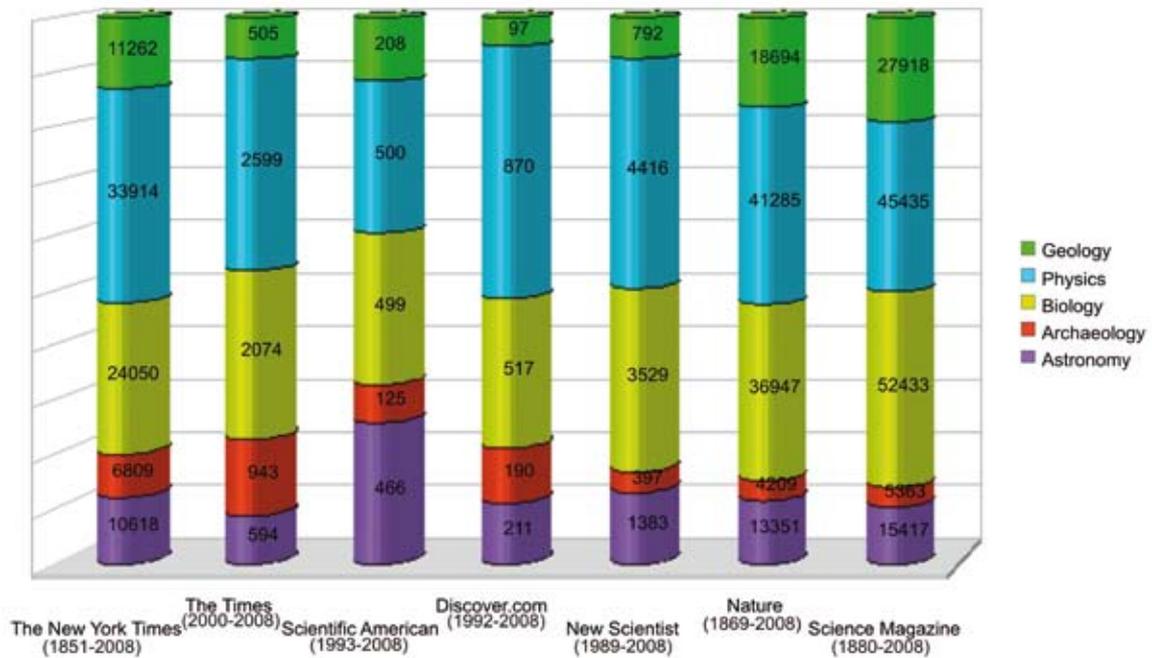


Fig. 3 - The chart shows the occurrence of the term “Geology” compared with other disciplines. Normalized results; the search ranges are the same of figure 1.

Fig. 3 - Il grafico mostra il numero di ricorrenze del termine “Geologia” comparato con altre discipline. Valori normalizzati; il periodo di ricerca è lo stesso di figura 1.

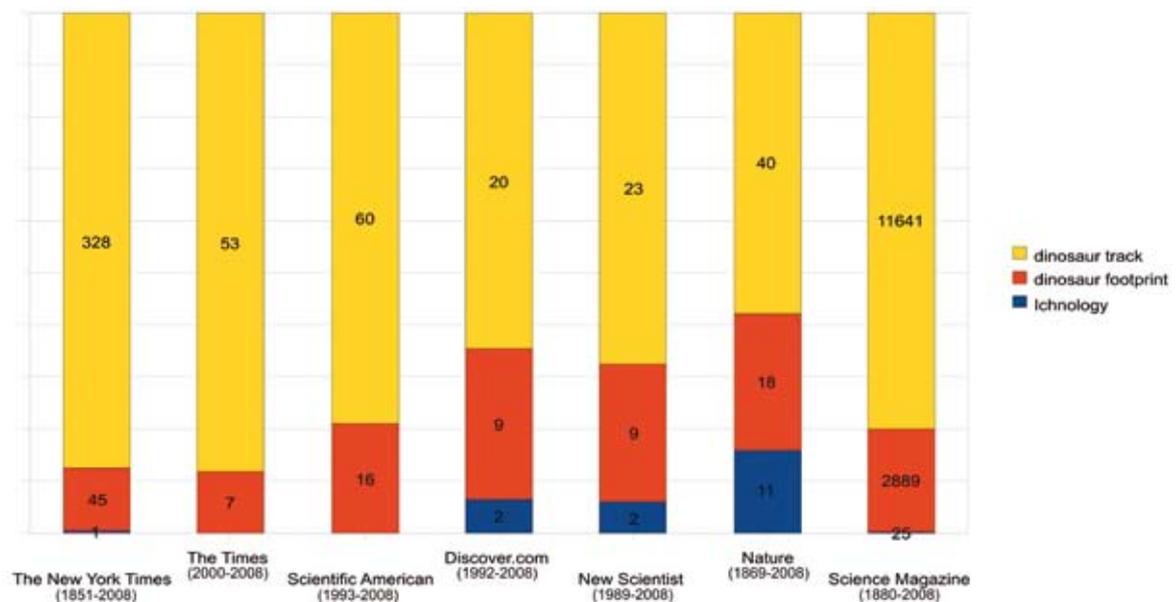


Fig. 4 - Does scientific press connect Ichnology with trace fossils? The term “Ichnology” occurs very rarely in popular science press, while ichnological terms – such as dinosaur footprint and track – are widespread. This fact shows that popular science press does not link trace fossils to Ichnology. Search range: see figure 1.

Fig. 4 - La stampa scientifica collega l'Icnologia alle tracce fossili? Il termine “Icnologia” ricorre molto raramente nella stampa di divulgazione scientifica, mentre termini icnologici – come impronta e pista di dinosauro – sono diffusi. Questo fatto mostra come la stampa di divulgazione non colleghi le tracce fossili all'Icnologia. Periodo di ricerca: vedi figura 1.

when these are discussed, Ichnology is never taken into account. Figure 4 reports how many search results are returned for “Ichnology”, “Dinosaur footprint”, “Dinosaur track” in scientific press: it clearly emerges that trace fossils are rarely referred to Ichnology.

The result of this attitude is perfectly mirrored in the “best-seller” of Ichnology-dinosaur footprints: people know what dinosaur footprints are, but they don't know what Ichnology is. This tendency is clearly confirmed by the online poll (Fig. 5) carried out for this study. People were asked

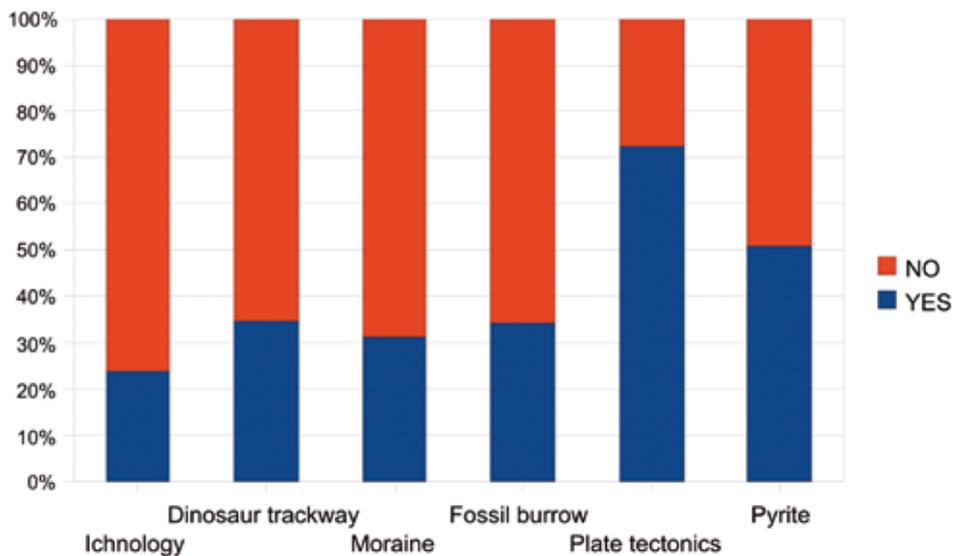


Fig. 5 - Do you know the meaning of...? The results of the on-line poll shows that general public does not link Ichnology to trace fossils. The poll refers to the same population described in figure 1.

Fig. 5 - Conosci il significato di...? I risultati del sondaggio on-line mostrano che il grande pubblico non collega l'Icnologia con le tracce fossili. Il sondaggio si riferisce alla stessa popolazione di figura 1.

about the terms “Ichnology”, “Dinosaur track”, “Fossil burrow”. The results are unequivocal: many are aware of ichnological terms (dinosaur track, fossil burrow) but they are ignoring the existence of Ichnology as a discipline.

Some numbers: the word “Ichnology” occurs once in the New York Times (search range: 1851-February 28, 2008; New York Times search engine). The only article found is from 1860 and it is quoting Hitchcock’s advances on Ichnology (sic). Dinosaur traces (tracks and footprints) are cited 373 times in the same time range. These results confirm what previously stated: scientific journalists do not link trace fossils with Ichnology (Fig. 5): as a consequence, general public is unaware of Ichnology, even when knowing of fossil footprints.

Some cases are even embarrassing. The article “Big dinosaur prints found” (*The New York Times*, 20/03/2008) reveals “*Archaeologists* have discovered fossils of dinosaur footprints in northwest China”, afterwards describing Zhao Xijin (Chinese paleontologist) as an *archaeologist*. Sad but true.

In conclusion, Ichnology lacks of visibility as a discipline by its own right; moreover, trace fossils are rarely linked to their science.

In order to confirm these results, a poll was addressed to the World Association of Scientific Journalists, but the answers are too few to be statistically valid.

1.2. Ichnology and media

Popular-science magazines revealed the meager status of Ichnology within the general public. The same scenario is found for other media, i.e. documentaries. Why does Ichnology have such a poor impact on media?

1. Appeal: at first sight, Ichnology lacks of the marvels typical of other disciplines. This becomes particularly evident when considering Invertebrate Ichnology. It

seems that a worm burrow is – apparently – less appealing than a dinosaur skeleton.

- Media receptivity: as mentioned above, Ichnology is poorly known outside of scientific institutions and it is visually less spectacular than other disciplines. Thus, it is not surprising that Discovery Channel prefers to bet on Egyptian tombs, rather than on *Dictyodora* and *Zoophycos*.
- What are Ichnologists doing for taking trace fossils outside from scientific journals? To answer this question, a survey has been addressed to ichnologists. Unfortunately, the participation was very low. In fact, the poll was sent to more than 200 contacts (that are the emails listed in the Ichnology and Skolithos newsletters), but only 27 answers were collected (April, 2008). Consequently, it is not possible to answer coherently to the question. Only some tendencies can be highlighted (Fig. 6), but they have to be considered as incomplete data. The poll would show that Ichnologists had not been active in popular science press (Fig. 6); even if this result has no statistic significance (due to the limited number of answers) it reflects the scenario previously highlighted. For instance, 20 authors (on a number of 27) never wrote a full paper on popular science magazines, although they used oral presentations and exhibits as the main channel for bringing Ichnology to popular science (Fig. 7).

In conclusion, the aforementioned results demonstrate that it is absolutely *necessary* to improve education of Ichnology. If not, such an engaging discipline will survive only within the parallel universe of Ichnologists.

Nevertheless, there are some prominent exceptions showing the potential impact of Ichnology on media. One of the most impressive examples is the visually spectacular *Volcanoes of the Deep Sea* (Low 2005) featuring Adolf Seilacher and the quest for *Palaeodictyon*. Ichnology-related

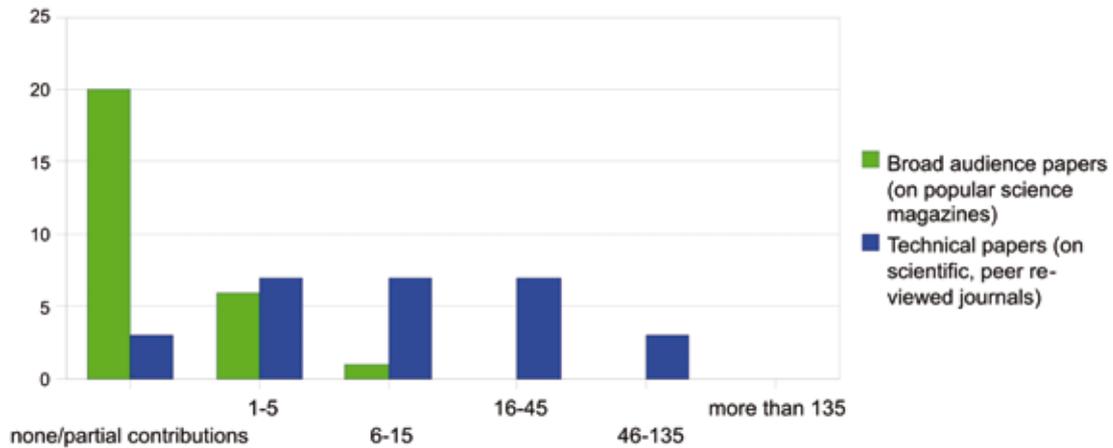


Fig. 6 - The chart shows the relationship between ichnologists, scientific and educational press. The classes on x-axis are related to the number of authored papers; y-axis corresponds to the number of authors that fits a certain class. The majority of the ichnologists interviewed never wrote on popular science magazines, and 6 authors wrote 1 to 5 popular science papers.

Fig. 6 - Relazione tra Icnologia, stampa scientifica e di divulgazione. Le categorie dell'asse delle ascisse si riferiscono al numero di articoli scritti; sull'asse delle ordinate è riportato il numero di autori che rientrano in una certa categoria. La maggior parte degli icnologi intervistati non ha mai scritto su riviste di divulgazione, e 6 autori hanno scritto da 1 a 5 articoli di divulgazione.

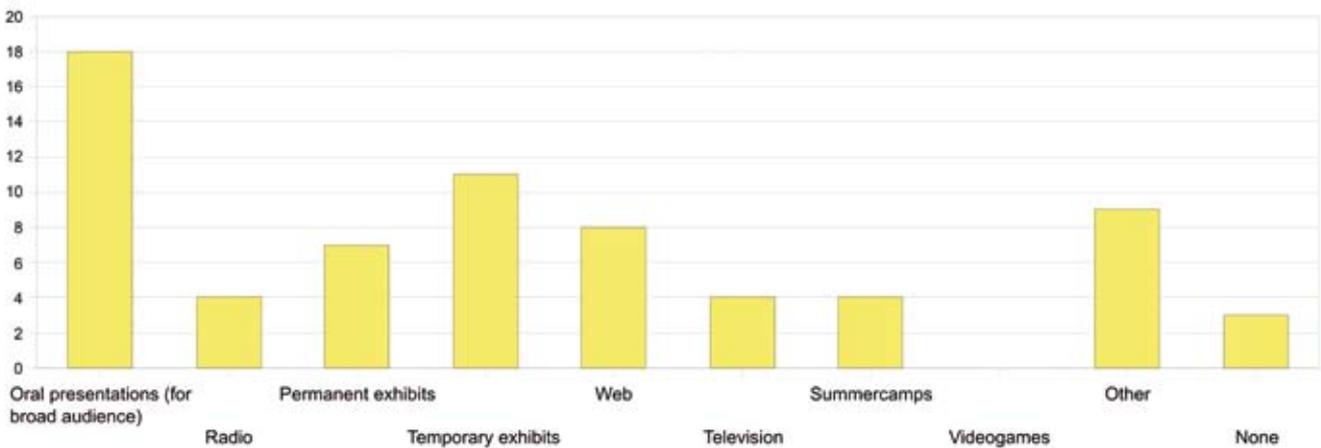


Fig. 7 - This chart reports the tools used by ichnologists to bring their discipline to the attention of broad audience. Oral communication is prevailing: 18 of them spoke about trace fossils in broad audience oral presentations.

Fig. 7 - Strumenti impiegati dagli icnologi per diffondere la loro disciplina ad un pubblico più ampio. La comunicazione orale prevale: 18 icnologi hanno discusso le tracce fossili in presentazioni orali divulgative.

videos are also found on YouTube (De Gibert 2007). Fossil Art exhibit presented trace fossils as pieces of art (Seilacher 1997). The award-winning Life in the Undergrowth (Gunton 2005) featured ichnological concepts, as well as the visually impressive Prehistoric Park (Kelly *et al.* 2006) and Shape of Life (Bowman *et al.* 2002; Braddy, pers. com.).

Ichnology needs a touch of refreshing vitality: for taking trace fossils outside from scientific journals, it is necessary to give visibility and appeal to it. Interactive divulgation tools are an effective way to explain Ichnology. This paper presents strategies and approaches developed for explaining the ichnological heritage of the Geopark Naturtejo Meseta Meridional – UNESCO European and Global Geopark (Portugal).

1.3. Ichnology and interactive media

It is well demonstrated that interactive media are extremely successful in science divulgation (i.e. Chen 2006). As for scientific exhibits, the display of the mere collection is no longer sufficient (see McLeod 2004). By quoting Caulton (2007): “Visitors are no longer satisfied by simply gazing at worthy displays in glass cases; they expect to have hands-on experience of the objects and be actively involved with the exhibits as a form of entertainment”. Interactivity changes the role of the visitors from passive spectators of collections to directly involved explorers of the exhibition (see Broadburne 2004; Black 2005). Interactive playing is a pro-

ficient way to explain concepts (Chen 2006). For these reasons interactive media are excellent tools for the divulgation of Ichnology.

2. TERRAGAZE

2.1. What is TERRAGAZE?

TERRAGAZE is a computer vision system developed for the exhibition “From trilobites to Man: 500 million years through Geopark Naturtejo Meseta Meridional” hosted in Lesvos Petrified Forest Geopark. The aim of the exhibit is to show the active tourism spirit of the Geopark and, at the same time, to explain its geologic heritage. This goal is not reachable by traditional media, either interactive (hypertexts, touch-screens...) or not (panels, videos...). For instance, traditional media show their limits when confronted with some of the most prominent geosites of Geopark Naturtejo, such as Penha Garcia or Portas do Rodão. Here the active tourism spirit is represented by outdoor sports (climbing, hiking, kayaking) and the geologic heritage is characterized by trace fossils within an impressive landscape. How is it possible to show these concepts to the visitor, giving him an immersing, engaging experience?

The answer is TERRAGAZE, a system constituted by a video-sensor, a computer vision software running on standard PC, and an output (monitors/projectors). This system makes real a virtual reality application characterized by an innovative and engaging concept: the input device is the body of the visitor. The visitor moves in front of the screen, and his actions have effect on the game.

The core of TERRAGAZE is a computer vision software which blend the visitor with virtual worlds. More precisely, the TERRAGAZE software is capable to “see” the visitor, extract his movements from real-time video footage, and make real his interaction with virtual objects.

2.2. From trilobites to man: TERRAGAZE in action

The exhibit “From trilobites to Man: 500 million years through Geopark Naturtejo Meseta Meridional” is a coherent example of a TERRAGAZE-based exhibition. In fact, it is conceived as a user-centered system in which visitors are actively involved in the learning process. Thanks to TERRAGAZE, “From Trilobites to Man” is a creative show in which the visitor is the main star.

In fact, the visitor takes profit of virtual reality to explore the most important geomonuments of the Geopark Naturtejo. Each of them represents a new adventure: seven stations take the visitor inside the wilderness of the Geopark. Selected TERRAGAZE stations are described below.

2.2.1. Cruziana maker

Target. The aim of this station is to explain the ichnologic heritage of Penha Garcia, a geosite renowned for its abundance of the trace fossil *Cruziana*.

Physical setting. The kiosk is constituted by a LCD screen and a platform equipped with directional lights. The visitor stands on the platform in front of the screen, where a top-view of the Ordovician seafloor is shown. Optionally, the visitor can wear two funny gloves mimicking trilobite limbs.

Concept. An on-screen message recites “Eat like a trilobite!”. The goal of the game is to move the arms (as trilobites would have done with their limbs) to eat and burrow. When the visitor swings the arms, the screen shows – in real-time – the scratch-marks that the visitor is virtually producing on the sea-floor (see Fig. 8). In this way, the visitor will learn about the feeding behavior of trilobites and the production of *Cruziana*.

There is more: visitors are invited to a challenge. In fact, the more they eat, the higher is their score. The score is represented by a trilobite avatar: with 0 points the avatar will be a protaspis (first stage of trilobite growth), with hi-



Fig. 8 - *Cruziana*-maker. a. The visitor faces a challenge: he has to eat as much as possible..., but to do it he must behave like a trilobite! b. When the visitor moves his arms, a scratch-mark appears on screen. The more the visitor “eats”, the more the trilobite grows... if you are fast enough you will see all stages from protaspis to holaspis!

Fig. 8 - Cruziana-maker. a. Il visitatore deve affrontare una sfida: deve mangiare il più possibile..., ma deve farlo come un trilobite! b. Quando il visitatore muove le braccia, delle tracce appaiono sullo schermo. Più il visitatore “mangia”, più il trilobite cresce... se è abbastanza veloce, potrà vedere tutti gli stadi di crescita di un trilobite dalla forma protaspide alla forma olaspide!

gher and higher scores it will become a meraspis and then a holaspis. In such a way the visitor will easily learn the ontogeny of trilobites.

This station met great success in the “Trilobites to Man” exhibition. People of all ages were swinging the limbs like trilobites! This fact shows how TERRAGAZE gives accurate scientific information and true fun.

Future improvements: This game could be upgraded as a Net multiplayer. Using an Internet connection, visitors from different Geoparks could challenge each other. Imagine two people from hundreds of kilometers of distance, chatting and challenging: let the “best *Cruziana*-maker” challenge begin!

Another feasible improvement involves a connection with a photographic printer: with this technology, the visitor can receive a photograph of himself and of his traces. This is a nice idea for a museum souvenir shop.

2.2.2. Kayaking among trace fossils

Target. This kiosk aims to explain the geological and ichnological features of the River Tejo and to provide the feelings of a real kayak-ride.

Physical setting. The kiosk is constituted by a kayak, where the visitor sits and uses a real paddle. This shows the strength of TERRAGAZE: even with no external peripherals (i.e. headset, glasses, VR gloves), the system is capable to “see” real-life objects. For instance, TERRAGAZE can perceive the movements of a real paddle, and the visitor can use it for virtual-kayaking in the Geopark.

The output of the game is represented by an LCD screen standing in front of the kayak.

Concept. The visitor is invited to actively explore the river. The screen in front of him shows a first-person viewpoint which “changes” in response to paddling. The visitor can really explore the river, for instance paddling to reach a certain point of interest. In this, the first-person viewpoint is fundamental to achieve a fully immersive experience.

This activity is not only limited to an enjoyment of the landscape: when the visitor approaches a point of geological/ichnological interest, the graphics explain the main features. For instance, when approaching an outcrop rich in *Skolithos* and *Cruziana*, the visitor will have information on ethology of suspension-feeders and trace fossil taphonomy. This experience results in a “guided geological tour” of the River Tejo (Fig. 9).

Future improvements. To add more realism to this experience, it could be possible to add “physical” stimulation of the visitor (i.e. rumbling when hitting obstacles) or it can be possible to empower the visual aspect with 3D techniques (i.e. by using anaglyphic or polarized glasses). With such improvements the kayak experience would become even more exciting!

2.2.3. Trilobite candid camera: it's *Diplichnites* time!

Target. This kiosk is placed at the end of the exhibit, aiming to surprise the visitor.

Physical setting. The TERRAGAZE system is completely concealed to the visitor who is unaware of what it is going to happen...

Concept. After the last kiosk of the exhibit, the visitor heads for the exit. When he enters the target area, a giant trilobite appears, projected on a wall: *Diplichnites* are pro-

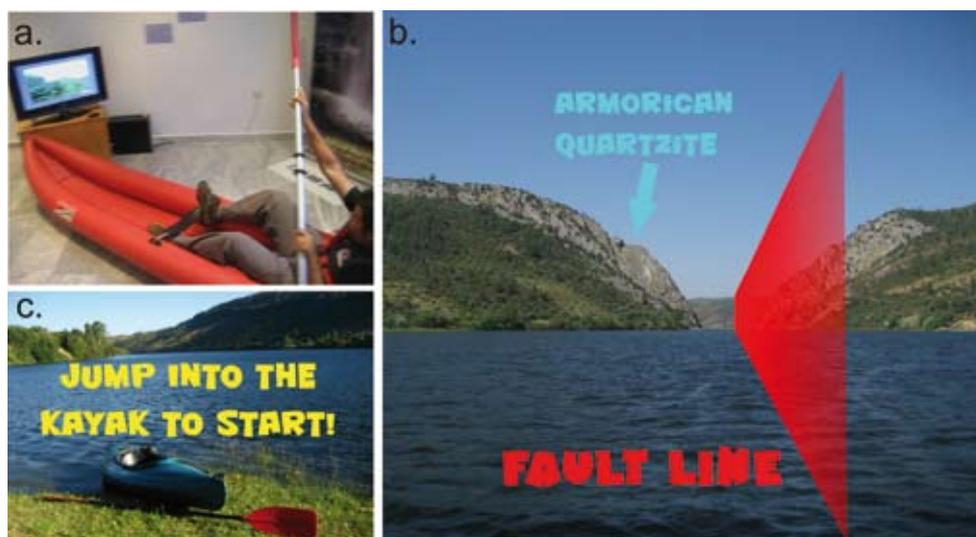


Fig. 9 - Kayaking among trace fossils. a. The visitor paddles in front of the screen: the faster he paddles, the faster he goes. b. Interpretative graphics fade-in during the virtual-kayaking: an interactive, visual approach to Geology. c. The start-game screen.

Fig. 9 - In kayak tra gli icnofossili. a. Il visitatore rema davanti allo schermo: più velocemente muove i remi, più velocemente va. b. Il viaggio virtuale è accompagnato da grafica illustrativa: si tratta dunque un approccio interattivo e visuale alla Geologia. c. La schermata di inizio gioco.

duced by the locomotion of the animal. The movements of the trilobite depend on the movements of the visitor. For instance, the visitor can interact in real-time with the trilobite just by moving his hands or trying to touch the extinct arthropod.

In conclusion, TERRAGAZE helps to construct a coherent narrative of the exhibit by creating interactive, engaging experiences. When the visitor sees himself on-screen, he has a more active approach and greater interest in what is going on. These elements are at the base of the success of the “From Trilobites to Man” exhibit: more than 35,000 visitors in just three months. The interactive approach of TERRAGAZE have been highlighted in other experiences, such as the “Geopark Management and Geotourism” course and the “Geomorphosites, Geoparks and Geotourism” workshop (held in 2007 at the Lesvos Natural History Museum, Greece); a kiosk powered by TERRAGAZE received significant attention in the UNESCO national meeting (2007, Knowledge Pavillion of Lisbon). More information can be found at www.terr gaze.com website (Baucon 2007).

TERRAGAZE achieves a balance between leisure and learning. This is an effective way to promote Ichnology within the Geopark territory: everyone will remember this intense, immersing virtual experience. By using this technique, Geoparks can present a larger variety and more connected material in an appealing manner, even within a limited physical space and a very low budget.

3. TERRAGAZE MOBILE

3.1. *What is TERRAGAZE mobile?*

Mobile phones are an integral part of our lives: they are used not only for phone calls but also for displaying various kinds of multimedia content – hypertexts, photos, movies, sounds, games are commonly present on mobile devices (i.e. Ling 2004). In addition to these elements, mobile phones offer extreme portability and consequently they are ideal systems to accompany visitors during a field visit.

For these reasons, mobile phones represent an excellent platform to host a portable version of TERRAGAZE: TERRAGAZE mobile. In fact, mobile phones have extraordinary potential for the divulgation of Ichnology. Multimedia mobile systems can really spark the visitor’s interest and get them engaged creatively.

One of the main problems that need to be addressed in regards to mobile phone technology and multimedia content is the variety of models of mobile available on the market, as well as the number of file formats.

Nowadays, the mobile market is aiming to an equal fruition of Web contents, using either computer or mobile. For these reasons, the World Wide Web Consortium (W3C) recently promoted the MWBP (Mobile Web Best Practices) which states the standards for ideating, designing, publi-

shing a mobile web site. Consequently, the MWBP represents an ideal standard to design a hypertext guide of an ichnosite for mobile phones. JAVA, the most common standard for mobile applications, has been adopted for TERRAGAZE’s highly interactive content.

3.2. *Ichnological Hiking with TERRAGAZE mobile*

TERRAGAZE mobile has been preliminarily tested as a tool for the presentation of the Penha Garcia Ichnological Trail: this trail is one of the most visited attractions of the Geopark Naturtejo, thanks to its impressive trace fossil heritage and the breath-taking natural landscape. The Trail starts in the traditional village of Penha Garcia, and explores the wilderness of the Ponsul River gorge. Rural beauty and wilderness: these elements are not fitting with invasive divulgative structures. In fact, physical interpretative structures – such as panels – would compromise the integrity of the landscape. How is it possible to give information to visitors without damaging the landscape? TERRAGAZE mobile constitutes a powerful and immediate solution to the problem.

With TERRAGAZE mobile the visitors use their own mobile phones as complete multimedia guides. The most significant ichnosites are presented by texts, images, sounds, movies. Penha Garcia ichnosite is explained by a multi-level narrative technique: as Hageböling (2004) frequently suggests, linear narrative traditions have to be abandoned to reach the potential of interactive media.

After downloading the required files on his mobile, the hiker is ready to visit the Ichnological Park with a complete field guide in the palm of his hand. Selected ichnosites are explained below.

3.2.1. *Cruziana ichnosite*

In the Ponsul gorge, trace fossils are a constituting element of the landscape: more in detail, *Cruziana* is the most evident ichnofossil of the Ichnological Park. With TERRAGAZE mobile, the hiker has access to a vast set of information about these trace fossils. By browsing the interactive menu, the visitor learns about trilobite anatomy and palaeoecology. For instance, the “Feed the trilobite!” section introduces to trilobite feeding behaviour; “Producing *Cruziana*” contains animations about the trilobite burrowing activity; “Ordovician seas” deals with the palaeoenvironment of Penha Garcia trilobites (Fig. 10).

3.2.2. *“Cobras pintadas” ichnosite*

For centuries, trace fossils had a special role in the Penha Garcia society. The inhabitants associated various legends to the trace fossils: *Cruziana* was interpreted as petrified snakes, and the elders still recount enchanted legends of princesses and “*Cruziana*-snakes”. The visitor can learn the anthropological significance of *Cruziana* than-

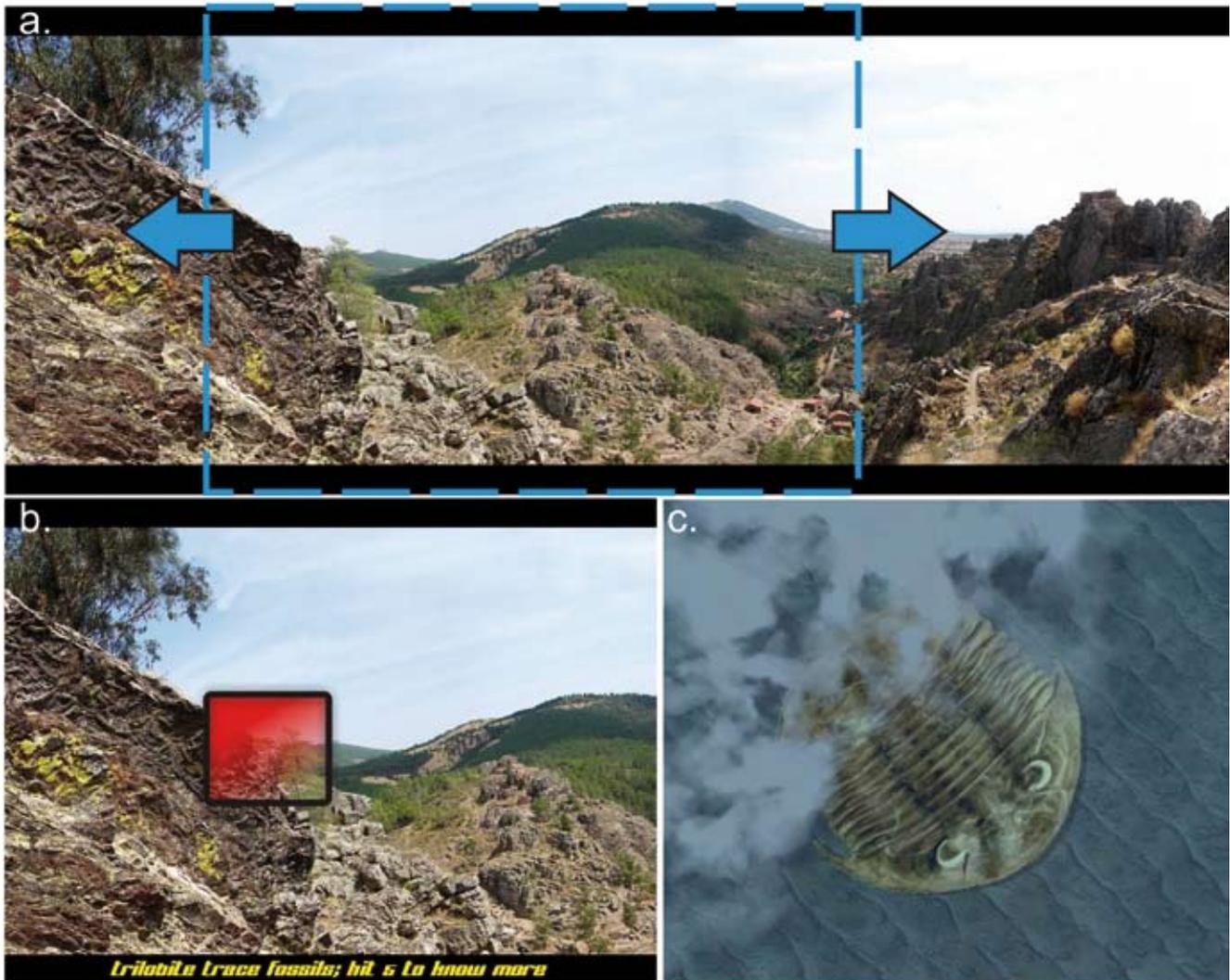


Fig. 10 - Interactive landscape interpretation with TERRAGAZE mobile. a. The visitor scrolls the landscape by using the control arrows of the mobile. The dashed rectangle represents the on-screen area. b. Graphics highlight points of geological/ichnological interest; a simple graphic user interface gives access to additional information (following) c. If the visitor clicks on the trace fossils (screenshot shown in b), he can browse more information, including animations of trilobites (figured).

Fig. 10 - Interpretazione interattiva del paesaggio con TERRAGAZE mobile. a. Il visitatore scorre il paesaggio con i cursori del telefono cellulare. Il rettangolo tratteggiato rappresenta l'area a schermo. b. La grafica evidenzia punti di interesse geologico/ichnologico; una semplice interfaccia dà accesso ad informazioni aggiuntive (segue). c. Se il visitatore fa clic sulle tracce fossili (schermata in b), può avere diverse informazioni, tra cui animazioni di trilobiti (in figura).

ks to TERRAGAZE mobile. An interactive menu give access to various multimedia content: movies where old shepherds narrate folk tales about *Cruziana*; pictures of meeting points signaled by trace fossils; texts of legends regarding ichnofossils.

3.2.3. *Diplocraterion* game

Diplocraterion is particularly abundant in some ichnosites of the Ichnological Park. How to explain spreite structures to the hiker? TERRAGAZE mobile hosts also interactive games, *Diplocraterion* being a great example. The user controls a worm-like creature living in a U-burrow; the aim

of the game is to maintain the position of the worm within a moving substrate. By shifting the position of the burrow, the user learns about spreite structures, equilibrium strategy and hydrodynamic environments (Fig. 11).

3.2.4. *Ichnosafari*

Educating on geoconservation is a fundamental issue for the Penha Garcia Ichnological Park. "Ichnosafari game" shows – in a fun way - the importance of geoconservation within Ichnosites. Thanks to TERRAGAZE mobile, the visitor participates to an ichnological photo safari. While physically hiking through the Ponsul gorge, he has to find and

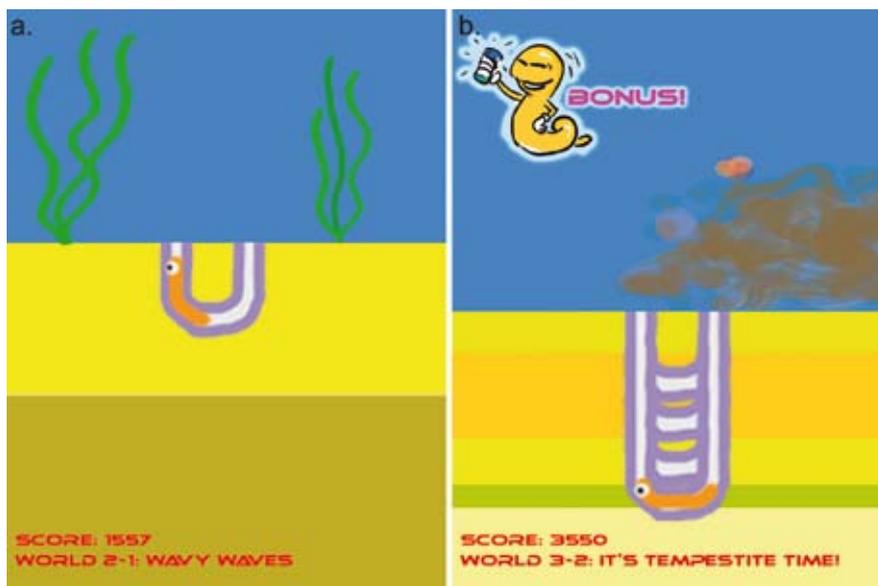


Fig. 11 - *Diplocraterion* game. a. Screenshot of the *Diplocraterion* game: the player controls the position of a burrowing worm by using the control arrows of the mobile phone. The aim of the game is to stay nearby the seafloor for suspension feeding. b. The burrowing worm has to face storm deposition: maintaining the position is not an easy matter!

Fig. 11 - Diplocraterion game. a. Schermata del Diplocraterion game: il giocatore controlla la posizione di un verme con i cursori del telefono cellulare. Lo scopo del gioco è stare nei pressi del fondale per nutrirsi del materiale in sospensione. b. Il verme deve fronteggiare eventi di rapida sedimentazione: mantenere la posizione non è facile quando c'è tempesta!

photograph - using the camera of his mobile phone - various ichnogenera. TERRAGAZE mobile encourages the visitor to be active and creative within interactivity.

The Penha Garcia portable guide demonstrates the potential of TERRAGAZE mobile in the field of ichnological divulgation. In fact, the strong points of TERRAGAZE include easy distribution (web download, CD-ROM), multimedia (field Ichnology through hypertexts, movies and videogames), portability (a field ichnological guide in your pocket), compatibility with mobile phones (applications can meet MWBP standards and mobileOK certification) and expandability (optionally the applications can satisfy higher technical requirements and compatibility with palms).

4. CONCLUSIONS

“Looking at dinosaur footprints in the rock seems a silly way for a grown man to make a living”

Greg Betty (2003), *Midnight at the Ichnologist's ball*

This study considered the status of Ichnology within the divulgation of sciences, and presented a new approach to explain trace fossils. More in detail, the following points have been demonstrated:

- *The insuccess of Ichnology.* This study confirmed the meager status of Ichnology: Ichnologists aside, almost no one knows of the existence of the discipline. Scientific research is separated from the general public, and Ichnology is unknown even to scientists.
- *Reasons of this insuccess.* What are the reasons for the poor status of Ichnology within science divulgation? Three interlinked causes have been individuated: firstly, Ichnology lacks of first-sight appeal; secondly, the receptivity in the media is low; and lastly ichnologists show a somehow passive attitude.

- *Breaking the divide.* There are some (but few) exceptions: a number of documentary movies (i.e. Low 2005) demonstrates that Ichnology can be presented to broad audiences with appeal, strong visuals and engaging narration. These cases show that it is possible to break the divide separating Ichnological research from the general public.
- *TERRAGAZE.* This study considers in detail TERRAGAZE, a multimedia system developed specifically for geological exhibitions and geotourism. TERRAGAZE presents an innovative approach to the divulgation of Ichnology: the visitor moves in front of a video sensor and his actions have effect on the game. This approach proved to be extremely engaging: interactive technologies are a great way to express Ichnology.
- *Impact of TERRAGAZE.* TERRAGAZE demonstrated to be a successful educational tool: in three months, more than 35000 people visited the TERRAGAZE-powered exhibit “From Trilobites to Man”. TERRAGAZE was presented at the “Geopark Management and Geotourism” course and “Geomorphosites, Geoparks and Geotourism” international workshop (Natural History Museum of Lesvos, Greece, 2007). TERRAGAZE was selected for participation in the UNESCO national meeting (Portugal 2007).
- *TERRAGAZE mobile.* Mobile phones are an ideal platform to host a portable version of TERRAGAZE. TERRAGAZE mobile is the ideal tool to accompany field visits to the ichnosites. The application is easily downloadable on a mobile phone, allowing the visitor to access a complete portable field guide of the ichnosite, with photos, sounds, texts, movies, maps, games.
- *Interactive media for Ichnology.* The present case study demonstrated the potential of interactive media for

bringing Ichnology to broader audience. TERRAGAZE and TERRAGAZE mobile make the learning experience richer, more interesting, more emotional, more meaningful, and, ultimately, more successful.

ACKNOWLEDGEMENTS

This paper greatly benefited of expert conversations with Simon Braddy (Bristol). We would like also to thank Jean-Marc Fleury and the World Federation of Scientific Journalists for the collaboration. We are also grateful to Elisa Tosoni for manuscript revision.

We thank the referees Vanda Faria dos Santos and Fabio Massimo Petti for their helpful comments.

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