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A NEW *RECORD* OF *OCYPODE ITALICA* (BRACHYURA: OCYPODIDAE) FROM THE PLIOCENE OF TUSCANY (CENTRAL ITALY)

Abstract - A. DI CENCIO, S. CASATI, A. COLLARETA, *A new* record of Ocypode italica (*Brachyura: Ocypodidae*) from the Pliocene of Tuscany (central Italy).

Well-preserved fossils of benthic marine invertebrates, including decapod crustaceans, are often found in the Pliocene sediments that constitute the substratum of the hills of Tuscany. Year after year, new or "exotic" taxa are found and documented, mostly thanks to isolated finds. In systematic paleontology, the ideal condition for instituting a new species is by working on many specimens: in this way, a newly instituted taxon may be described on the basis of the holotype and other specimens that would depict its intraspecific variability. That said, given the fragmentary nature of the fossil record, this happens rarely, and several extinct species are instituted and described based on very few specimens. It is the case for the ghost crab Ocypode italica Garassino et al., 2010 (Decapoda: Brachyura: Ocypodidae), which was known so far by the holotype and one paratype. Recently, thanks to the cooperation between some citizen scientists and academically educated paleontologists, a well-preserved new specimen of O. italica was collected from the same upper Pliocene deposits of Tuscany (central Italy) from which the type specimens originate. Our new find represents the third known specimen of this extinct species, and as such, it allows to better characterize the anatomy of the carapace, chelipeds and walking legs of this rarely occurring ghost crab. In the present work we report on this new find and briefly discuss its palaeontological significance.

Key words - Brachyura, Crustacea, Decapoda, ghost crabs, Pliocene, Tuscany

Riassunto - A. DI CENCIO, S. CASATI, A. COLLARETA, Un nuovo esemplare di Ocypode italica (Brachyura: Ocypodidae) dal Pliocene della Toscana (Italia centrale).

Nei sedimenti pliocenici che costituiscono il substrato delle colline toscane sono spesso rinvenuti fossili di invertebrati marini bentonici molto ben conservati. Sebbene anno dopo anno vengano rinvenuti e documentati taxa nuovi o "esotici", tali ritrovamenti hanno spesso carattere puntuale. Tuttavia, in paleontologia sistematica, la condizione ideale per l'istituzione di nuove specie sta nel confronto di numerosi esemplari, così che una specie possa essere stabilita sulla base dell'olotipo e di un grande numero di altri esemplari che ne illustrino la diversità intraspecifica. Molto spesso, questa condizione ideale non è applicabile, data la natura frammentaria del record paleontologico, e molte specie estinte di animali o piante sono istituite su pochi esemplari. È il caso della specie Ocypode italica Garassino et al., 2010 (Decapoda: Brachyura: Ocypodidae), conosciuto per l'olotipo ed un paratipo. Recentemente, un nuovo esemplare di O. italica è stato rinvenuto grazie alla collaborazione tra collezionisti locali e paleontologi accademici. Esso rappresenta il terzo esemplare conosciuto di tale specie e permette una migliore definizione

dell'anatomia del carapace, delle chele e delle gambe di questa specie di granchio fantasma. Nel presente lavoro gli autori riportano il nuovo ritrovamento e ne discutono brevemente il significato paleontologico.

Parole chiave - Brachyura, Crustacea, Decapoda, granchi fantasma, Pliocene, Toscana

INTRODUCTION

The Pliocene deposits of Tuscany (central Italy) feature abundant well-preserved fossil specimens of animals and plants that lived on the lands and along the coasts of present-day Italy c. 5.3 to 2.6 million years ago (hereinafter: Ma). Still in recent times, records of new (e.g. Bisconti, 2002; Bianucci & Landini, 2003; Garassino et al., 2010, 2012; Bianucci et al., 2019) or "exotic" taxa (e.g., Collareta et al., 2017a, b, 2018) are relatively common from these deposits. Continuous findings of well-preserved specimens are made possible thanks to several local collectors, whose cooperation with academically educated paleontologists allows to monitor a very large territory in an efficient way. When the passion of amateur collectors meets the work of professional scientists, new knowledge about the Pliocene paleoecosystems of Tuscany arises (e.g., Bianucci et al., 2009; Cigala Fulgosi et al., 2009). Findings from Pliocene terrains of Tuscany mainly include marine vertebrates (such as toothed and baleen-bearing whales, elasmobranchs, and bony fishes) and benthic invertebrates (such as echinoderms, bivalves, gastropods, and crustaceans). In several cases, findings are typically punctual and build up a highly fragmentary and often lacunous fossil record, sometimes integrated by sophisticated detection techniques (e.g., Tinelli et al., 2012). Consequently, new species are often instituted on the basis of the sole holotype or a very little number of specimens; therefore, it is possible to find further and well preserved material later. It is the case of a new specimen of the fossil ghost crab Ocypode italica Garassino et al., 2010, stored in the permanent exhibition of "Gruppo AVIS Mineralogia e Paleontologia Scandicci" (Badia a Settimo, Scandicci, Florence

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Province, Italy) and here described and figured (Fig. 1, Pl. I). This specimen was collected from the same deposit that hosted the holotype of the species, close to the Poggibonsi village (Siena Province, Italy). Since it exhibits a very good preservation state, the aim of this paper is to expand the description of *O. italica* on the basis of this newly discovered, well-preserved specimen. The fossil specimen described herein has been previously prepared for exhibition by means of mechanical removal of the sand that covered the upper side of the specimen and subsequent chemical consolidation. As such, it displays most of the external and dorsal features, whereas the abdominal region is hidden beneath a block of the sandy matrix that originally embedded the specimen. The partial preparation of the fossil specimen allows for the observation of a fragment of the dactyl that was dislocated and moved afar from the carapace of the crab. No information about the sex of specimen is available. The original description, measurements, and remarks about Ocypode italica have been provided by Garassino et al. (2010). Here some further considerations follow.

Systematic Palaeontology

Phylum ARTHROPODA Latreille, 1829 Subphylum CRUSTACEA Brünnich, 1772 Class MALACOSTRACA Latreille, 1802 Order DECAPODA Latreille, 1802 Infraorder BRACHYURA Linnaeus, 1758 Family OCYPODIDAE Rafinesque, 1815 Subfamily OCYPODINAE Rafinesque, 1815 Genus *Ocypode* Weber, 1795

Ocypode italica Garassino, De Angeli, Pasini & Tangocci, 2010



Figure 1. *Ocypode italica* Garassino *et al.*, 2010, specimen GAMPS-00206, kept at the G.A.M.P.S. exhibition in Scandicci (Florence, Central Italy). This specimen is prepared for exhibition and its lower aspect is still hidden beneath a block of the original matrix. This photograph has been taken with the specimen dry and uncoated.

* 2010 Ocypode italica Garassino et al., p. 139, figs. 3, 4, 5. ? 2014 Ocypode sp. Betancort et al., p. 345, pl. 1, figs. L1, L2, L3.

Material

One specimen, currently kept at Badia a Settimo (Scandicci, Italy), in the permanent exhibition of "Gruppo AVIS Mineralogia e Paleontologia Scandicci" (G.A.M.P.S.) under inventory number GAMPS-00206.

Description

Three-dimensional, box-shaped carapace that is wider than long and longer than high. The original volume of the carapace seems to be preserved despite the numerous fractures that affect the fossil (Tab. 1).

Table 1. Measurements of *Ocypode italica* Garassino *et al.* 2010, specimen GAMPS-00206, kept at the G.A.M.P.S. exhibition in Scandicci (Florence, Central Italy).

	cl	cw	wo-f	wf	wo
GAMPS - 00206	27.0	44.55	45.35	5.5	21.4

Abbreviations: cl - carapace length; cw - carapace width; wo-f - width of orbito-frontal margin; wf - width of frontal margin; wo - width of orbit. All measurements are given in millimeters.

The general size and morphology and the details of the architecture of the carapace seem to be in agreement with the description of the type specimens. The dorsal portion of the carapace exhibits sub-rounded lateral and caudal margins. The transition between the dorsal and posterior portions of the carapace is rounded and without any morphological discontinuity (Pl. I, fig. b). The dorsal aspect of the carapace is fractured, but two sinuous and more or less symmetrical gastro-hepatic grooves are well recognizable at both sides of the sagittal plane (Pl. I, fig. b). The back portion of the carapace is ornamented by the presence of two holes on the lower side (Pl. I, fig. c). In correspondence of the walking legs, the posterior halves of both the sides of the carapace (Pl. I, fig. e) are convex. The anterior halves are concave and shaped as niches for the chelipeds during relax or rest. The anterior portion of the carapace displays a mask with two strong orbits separated by a rostrum, which represents a typical feature for Ocypode italica (Pl. I, fig. f). The upper portion of the frontal region is characterized by two sinuous orbits, each being wide just one third of the total width of the carapace. The margin of the orbits, and in particular the upper one, are thick on the external side, which is shaped as a very sharp crest. The orbits are separated by a long, bulge-like medial rostrum. In the lower part of the frontal portion, there are no ornamented oral appendices and the exoskeleton seems to be continuous.

The chelipeds are very well preserved: each of them consists of three short and robust metamers (Pl. I, figs. g, h), their transverse sections being triangular. As observed in all ghost crabs (Sakai & Türkay, 2013), the chelae are asymmetrical. In the studied specimen, the right chela is bigger and has a better postural exposition than the left one (Pl. I, fig. g). Its upper side is globose, whereas its lower side is keeled. The surface of the chela is rounded and characterized by the same granulation pattern observed on the rest of carapace. The dactylus and pollex (or fixed finger) of the propodus exhibit lateral keels. The pollex is short, sub-triangular in shape, with a pointed distal termination. It is crossed by two keels, the lower one being thicker than the upper one, which divide the chelae in three more or less equal parts. The occlusal side of the pollex is crossed by short and unaligned teeth.

The dactylus is thinner than the pollex, hexagonal in cross section, lined by five keels that depict five corners of a hexagon (in which the sixth one is the occlusal margin), and crossed by short and unaligned teeth. Teeth number six on both the pollex and the dactylus.

The left chela is slimmer and thinner than the right one (Pl. I, fig. h). It displays a more or less flat palm and outer manus, which terminates in a longitudinal keel on the bottom side and in a sub-rounded margin on the upper side. The chela is finely granulated throughout. The pollex is thin and triangular in shape. It is crossed by a longitudinal pair of keels, of which the lower one is stronger than the upper one. The same design is observable on the inner side of the claw, providing it with a hexagonal cross section. The dactylus is longer than the pollex; it is crossed by several longitudinal keels that provide it with a polygonal outline in cross section. On the inner side of the chela, the keels are large and rounded, and the space between them becomes similar to grooves.

The walking legs are comprised of three preserved elements: merus, carpus, and propodus (Pl. I, fig. d). Their cross section is sub-triangular, while their longitudinal section is sub-rectangular. The dactyli are missing in all the preserved legs, but a single piece of them is found in the sediment, close to the rest of the specimen. All the parts of the legs are finely granulated throughout. The meri are well preserved, being long and ornamented by fine transverse ribs (Pl. I, fig. a). The ribs seem to overlap each other, thus creating a sort of buttress-like enforcement on the upper side of the meri. All along the surface of the meri, the granulation is best observable along the ribs. The proximal termination of each merus is characterized by a shrinkage of the transversal section that looses ornamentation too. The carpus starts from inside the distal part of merus. It is crossed by several well-spaced longitudinal keels that provide it with a sub-polygonal section. Propodi and dactyli are poorly preserved and substantially uninformative.

Occurrence

Upper Pliocene (Piacenzian) deposits exposed at Poggibonsi (Tuscany, central Italy; indicative geographic coordinates: 43° 30' 44.75" N, 11° 09' 33.92" E). GAMPS-00206 comes from the same strata that also provided the type material of *Ocypode italica*. Recently, some fossil material classified as belonging to Ocypode sp. was found in Mio-Pliocene sediments of Fuerteventura (Canary islands, Spain) by Betancort et al. (2014). These authors considered their ocypodine material as belonging to Ocypode sp., even though they had compared it with the holotype of *Ocypode* italica. The main difference observed by Betancort et al. (2014) between O. italica and the Ocypode material found in the Canary lies in the shape of the chelipeds. Nevertheless, the anatomical features of the material from Fuerteventura are very similar to the corresponding ones of the Italian specimen here discussed. We propose that the material of Betancort *et al.* (2014) might be tentatively referred to Ocypode italica.

PALAEOECOLOGY AND TAPHONOMY

As highlighted above, GAMPS-00206 represents the third known specimen of *Ocypode italica*. Among the Neogene record of decapod crustaceans from Italy, the three known specimens of O. *italica* represent the northernmost finds of the genus Ocypode in the Mediterranean Basin, as well as the geologically oldest species of Ocypode in Europe (Garassino et al., 2010). Although Radwanski et al. (2012) reported on the presence of the ichnospecies Psilonichnus upsilon Frey et al., 1984, consisting of J- or Y-shaped burrows possibily related to the activity of *Ocypode*, from the Miocene of Ukraina (Paratethys), they did not found any body fossil hinting at this brachyuran genus. Such a limited fossil record is typical of *Ocypode* spp. and might reflect the habitat preferences of this group of ghost crab species, currently inhabiting high-energy sandy shores at tropical and subtropical latitudes worldwide (Sakai & Türkay, 2013).

As already observed by Garassino *et al.* (2010), anatomical resemblances between *O. italica* and the extant species *Ocypode cursor* (Linnaeus, 1758) are strong and might suggest similar ecological and trophic habits for these two Mediterranean species. Nowadays, *O. cursor* is present along the beaches of Gela (southern Sicily, southern Italy), where these ghost crabs live on sandy shores (Zafarana & Nardo, 2016; Deidun *et al.*, 2017), creating their burrows in sediment that recalls the matrix embedding the fossil specimen here studied in terms of granulometry. As all other ghost crabs, extant *Ocypode* spp. excavate their burrows (sometimes more than one per individual; Silva & Calado, 2013) in the sand that comprises the terrestrial or semi-ter-



restrial portions of the beaches they inhabit (Portell *et al.*, 2003; Luque *et al.*, 2018). These actualistic data seem to be in agreement with the characteristics of the deposit in which the fossil specimen here described was found. This deposit is comprised of well-sorted, loose or poorly cemented, monogenic sand. It is thus possible to hypothesize that, during part of the Pliocene, the Poggibonsi marginal-marine area was characterized by environmental conditions similar to those currently observed along the beaches of Ragusa, Gela or Malta and, more generally, along the low-latitude sandy coasts of the Mediterranean Sea.

Some consideration about the posture and completeness state of the fossil specimen here studied have to be done. This specimen appears in a relaxed position, and this suggests that death occurred as consequence of a quick and sudden depositional event that buried the animal, leaving it without any chance of safety or escape. The completeness state of GAMPS-00206 also supports this hypothetical scenario. In spite of the incoherent nature of the entombing sediments, the exoskeleton of *Ocypode italica* is indeed almost completely preserved, suggesting that the carcass was not subject to the action of currents or scavenging before its eventual burial. Furthermore, fossil-diagenesis was not invasive, allowing in turn to preserve and underline the fine anatomical details of the exoskeleton.

CONCLUDING REMARKS

In systematic palaeontology, the ideal condition for instituting a new species is by working on several specimens. In this way, new species may be described on the basis of the holotype and other specimens that would depict the intraspecific variety of the newly instituted taxon. That said, given the fragmentary nature of the fossil record, this ideal condition is often far to occur, and several extinct species are instituted and described based on very few specimens. Nevertheless, each time a new specimen of a given species is found, it might give further valuable information on its morphology, which could ultimately open new windows on its physiology, functional morphology, palaeoecology, and phylogenetic relationships, especially when the species is represented by the sole holotype or by a few published specimens. In particular, in the present work, we reported on the third known specimen of Ocypode italica, whose description allowed us to better define the anatomy of the carapace, chelipeds and legs of this extinct species of ghost crabs.

As already observed elsewhere, the strong anatomical resemblances between O. italica and the extant Ocypode cursor evoke similar ecological and trophic habits. Ocypode italica from the Pliocene of Tuscany likely lived on sandy beaches, characterized by tropical or subtropical climate conditions, similar to those inhabited by the extant species of the genus. Other important information is obtained when considering the completeness state of the exquisitely preserved specimen of O. italica described herein. Indeed, coupled with the seemingly relaxed posture, this support that the crab was buried during a quick and sudden depositional event. Lastly, our findings encourage to pursue the quest for fossils of decapod crustaceans in the globally famous Pliocene fossiliferous beds of Tuscany.

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Pl. I. Plate depicting the skeletal anatomy of *Ocypode italica* Garassino *et al.* 2010, specimen GAMPS-00206, kept at the G.A.M.P.S. exhibition in Scandicci (Florence, Central Italy). a) general frontal view; b) dorsal view of the carapace with sulci; c) posterior view of carapace with burrows; d) particular of the triangular-shaped transverse sections of the legs; e) detail of the lateral face of the carapace, shaped as a niche for the chelipeds during relax or rest; f) detail of the mask; g) close-up on the right cheliped; h) close-up on the left cheliped. Scale bars equal 1 cm. All the photographs have been taken with the specimen dry and uncoated.

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