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On the occurrence of *Iphiculus eliasi* Hyžný & Gross, 2016 (Decapoda, Brachyura, Leucosioidea) from the Miocene of Catalonia (northeastern Iberian Peninsula)

Novi podatki o razširjenosti vrste *Iphiculus eliasi* Hyžný & Gross, 2016 (Decapoda, Brachyura, Leucosioidea) iz miocena Katalonije (severovzhod Iberijskega polotoka)

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Ključne besede: Leucosioidea, Iphiculidae, miocen, langhij, Katalonija

Abstract

Recovery of two specimens of leucosioid crabs in Langhian (middle Miocene) strata at Vilafranca del Penedès (Alt Penedès, Catalonia) and a re-examination of another leucosioid from the palaeontological collections of the Vinseum (Vilafranca del Penedès, Catalonia) have led us to consider all of these as conspecific with *Iphiculus eliasi* Hyžný & Gross, 2016, described first from the middle Miocene of Austria. The sternal and pleonal remains preserved in one of the Catalonian specimens allows to emend the original description of the species. Likewise, a specimen from the middle Miocene of Portugal, previously described as a paguroid, is herein transferred to this species. The occurrence of *I. eliasi*, either in outcrops along the northeastern and southwestern coasts of the Iberian Peninsula, corroborates the close relationship between decapod assemblages which inhabited similar palaeoenvironments in the Central Paratethys, the western Mediterranean and even the nearest Atlantic waters, during the middle Miocene.

Izvleček

Dva nova primerka leukosioidnih rakov langhijske (srednjemiocenske) starosti iz kraja Vilafranca del Penedès (Alt Penedès, Katalonija) in dodaten primerek iz muzeja Vinseum (Vilafranca del Penedès, Katalonija) smo določili kot *Iphiculus eliasi* Hyžný & Gross, 2016, ki je bil prvič opisan iz srednjemiocenskih plasti Avstrije. Na podlagi dobro ohranjenih morfoloških podrobnosti sternuma in pleona lahko dopolnimo originalni opis vrste. Primerek iz srednjega miocena Portugalske je določen kot *I. eliasi*, ki je bil opisan kot ostanek raka samotarja. Razširjenost vrste *I. eliasi* na iberijskem polotoku dodatno potrjuje podobnosti med fosilnimi združbami deseteronožcev, ki so v srednjem miocenu poseljevale centralno Paratetido, zahodno Sredozemlje in plitvovodna območja v Atlantskem oceanu.

Introduction

Miocene decapod crustacean assemblages of the Vallès-Penedès and Camp de Tarragona basins (northeastern Iberian Peninsula) have been studied by a number of scholars and are well known (Almera, 1896; Via, 1932; Solé & Via, 1989; Müller, 1993; Artal, 2008; Garassino et al., 2009; Ossó, 2010). Moreover, due to collecting efforts by enthusiastic fossil hunters new occurrences are constantly being reported, thus expanding our knowledge of fossil decapod crustacean assemblages of these areas. One such occurrence is recorded in the present contribution.

Müller (1993) summarised Neogene decapod crustaceans known at that time from Catalonia and described a number of new taxa, mainly from the reef limestones of Olèrdola, as well as from Vilafranca del Penedès and Santa Margarida i Els Monjos (Alt Penedès). More than a decade ago, a large number of fossil decapods, mainly *Palaeopinnixa mytilicola* Vía, 1966 were recovered in the so-called Vilafranca marls (Langhian), extracted during construction works for the high-speed railway line on the outskirts of Vilafranca del Penedès. Among these, remains of a carapace and a counterpart of a male venter of a leucosioid crab were recovered. The taxonomic assessment of this leucosioid is the goal of the present report.

Geological setting

The material studied comes from the localities of Vilafranca del Penedès and Santa Margarida i els Monjos, both within the Vallès-Penedès Basin and exposing Miocene strata. This basin represents a NE-SW-oriented depression limited to the northwest and to the southeast by the Prelitoral and Litoral ranges, respectively, which are made of Palaeozoic and Mesozoic rocks. The Vallès-Penedès Basin corresponds to the emerged part of the NE-SW and NNW-SSE horst and half-graben system formed during the Oligocene-Miocene opening of the western Mediterranean (Bartrina et al., 1992; Cabrera & Calvet, 1996; Roca et al., 1999; Cabrera et al., 2004) (Fig. 1). Rifting and thermal subsidence related with this opening led to the accumulation of marine and continental sediments in the Vallès-Penedès Basin,

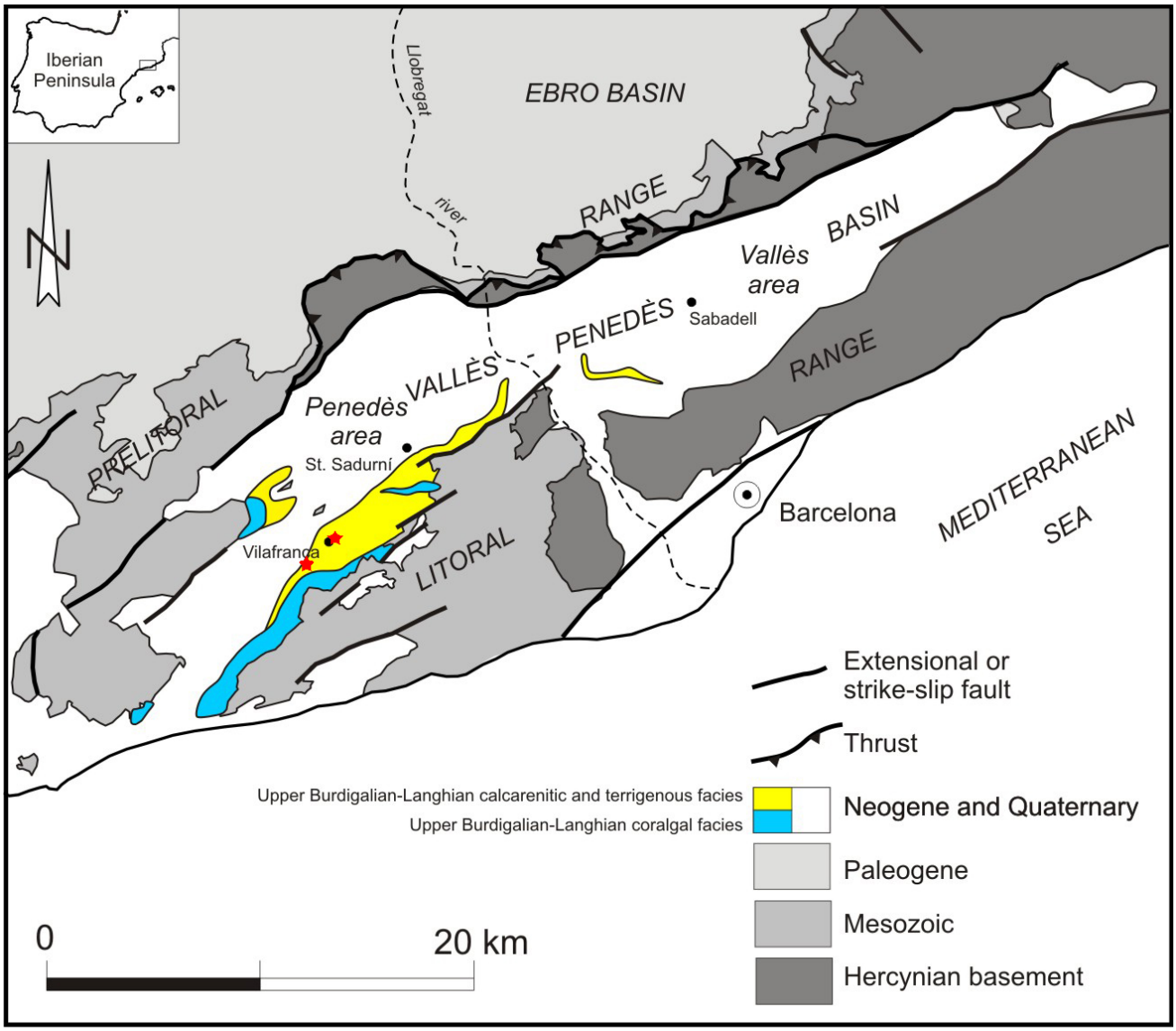

Fig. 1. Simplified geological map of the Vallès-Penedès Basin (modified from Roca et al., 2004). The main upper Burdigalian-Langhian coralgal and calcarenitic-terrigenous facies are indicated. The red stars indicate the location of the outcrops.

from the early to late Miocene (early Burdigalian to Tortonian), as discussed in detail by Cabrera et al. (2004) and Casanovas-Vilar et al. (2016). Although most of the Vallès-Penedès sedimentary infill is of terrestrial origin, three transgressions occurred during the late Burdigalian, Langhian and early Serravallian, leading to the deposition of various marine facies (Cabrera et al., 1991; Cabrera & Calvet, 1996; Roca et al., 1999). During the most significant Langhian transgression, a shallow sea developed in the Penedès area, where fringing reefs, carbonate platform and ramp sediments, open marine marls and transitional shales and sands were laid down.

At the Vilafranca site, grey marls with interbedded levels of fine sands, located predominantly at the top of the unit, are exposed. Based on borehole data, the unit attains a thickness of approximately 300 m (Permanyer, 1982; Cabrera et al., 1991) and it extends across the Penedès Basin and also south of the Llobregat River, including the southernmost part of the Vallès Basin. The presence of the unit is more significant in the southwest of the Penedès depression, where it occupies a central part below younger terrestrial and marine deposits. Towards the northeast, the grey marls are thinner and located along the southeastern margin of the basin. The unit is well exposed in a number of outcrops near the towns of Vilafranca del Penedès, Sant Sadurní d'Anoia, Can Rosell (Subirats), Cerdanyola or Rubí; some of them have yielded decapod crustacean remains (Müller, 1993; Artal, 2008; Garassino et al., 2009). The Vilafranca marls contain also bivalves, gastropods, echinoids, benthic and planktonic foraminifera, as well as remains of flora (Permanyer, 1982). The age of the unit is based on planktonic foraminifera: late Burdigalian to Langhian (Macpherson, 1994). The marls are interpreted to have formed in an offshore environment (Permanyer, 1982; Cabrera et al., 1991), although towards the top of the unit they must have originated in a progressively shallower environment. The crab-bearing levels are located in the middle of the sections studied and are attributed to the Langhian.

At the Santa Margarida site, about two kilometres southwest of Vilafranca del Penedès, fossiliferous and intensely bioturbated yellowish calcarenites, alternating with calcisiltites or marls, crop out. Calcisiltites and marls are more frequent towards the middle of the basin (to the northwest), whereas calcisiltites prevail towards the basinal margin (to the southeast). These sediments are several tens of metres thick and are well exposed along a SW-NE strip attached to the Prelitoral range, south of the town of Vilafranca, near the villages of Moja, Santa Margarida i els Monjos and Castellet, among others. The calcarenites are rich in fragments of red algae, planktonic and benthic foraminifera, corals, molluscs, echinoids, fish teeth and decapod crustaceans. Their age ranges from late Burdigalian to Langhian (Macpherson, 1994). The unit is located in a transition zone between the carbonate ramp to the southeast and the open marine basin marls to the northwest. It is interpreted to represent distal deposits as a result of erosion and transport of sediments originating in the adjacent coralgal complex. Decapod crustacean assemblage at the Santa Margarida site is dominated by portunids such as *Portunus monspeliensis* (A. Milne-Edwards, 1860) and *Necronectes batalleri* (Via, 1941). The crab-bearing calcarenites and marls of this unit are similar to Serravallian strata in the Camp Basin, which also yield remains of the same crab species (Via, 1932; Ossó, 2010).

Repositories: MGB, Museu de Geologia de Barcelona-Museu de Ciències Naturals de Barcelona (Catalonia); MV, Museu de Vilafranca "Vinseum" (Vilafranca del Penedès, Catalonia).

Systematic palaeontology

Order Decapoda Latreille, 1802
Infraorder Brachyura Latreille, 1802
Section Eubrachyura de Saint Laurent, 1980
Subsection Heterotremata Guinot, 1977
Superfamily Leucosioidea Samouelle, 1819
Family Iphiculidae Alcock, 1896

Iphiculus Adams & White, 1849
Type species - *Iphiculus spongiosus* Adams & White, 1849, by monotypy.

Iphiculus eliasi Hyžný & Gross, 2016
Figures 2A-E, 3A-E

1941 Illinae, Ebaliinae? - Vía, p. 68, pl. 10, fig. 75.

partim 1965 *Petrochirus* cfr. *priscus* Brocchi - Veiga Ferreira, p. 142, pl. 2, fig. 8 [*non* figs. 7, 9, 11, 12 = *Petrochirus priscus*]

1993 *Randallia*? sp. - Müller, p. 12, figs. M-N.

2016 *Iphiculus eliasi* Hyžný & Gross, p. 266, figs. 2A, 3A-E, 4A-C.

Material and measurements (in mm): MGB 89842 (internal mould of near-complete dorsal carapace): length=14.5; width=17.0; fronto-orbital width=6.0. MV15169 (internal mould of complete dorsal carapace preserving remains of cuticle): length=14.5; width=17.5; fronto-orbital width=6.0. MGB 89843 (counterpart of a male venter): length=8.0; width=10.5.

Emended description: Carapace small, transversely subovate in outline, widest at midlength (at level of posteriormost anterolateral spine), dorsal surface moderately convex in both directions. Front not projected, bilobed, slightly raised, very narrow, about 0.13 of total width, medially notched, strongly divergent. Orbits small, concave, anteriorly directed; outer orbital spine acute; inner orbital spine fused with frontal lobe; supraorbital margin with subtriangular spine, bounded by two open fissures. Fronto-orbital margin about 0.35 of total width. Lateral margins with 6 conical teeth; anterolateral margin with 4 teeth, fourth being most prominent; posterolateral margin with 2 teeth; corners between posterolateral and posterior margins pointed; posterior margin straight, narrow, medially notched. Dorsal surface of carapace evenly covered with numerous densely packed granules, nearly identical in size (when cuticular surface preserved) or with round concave pustules (when cuticular surface

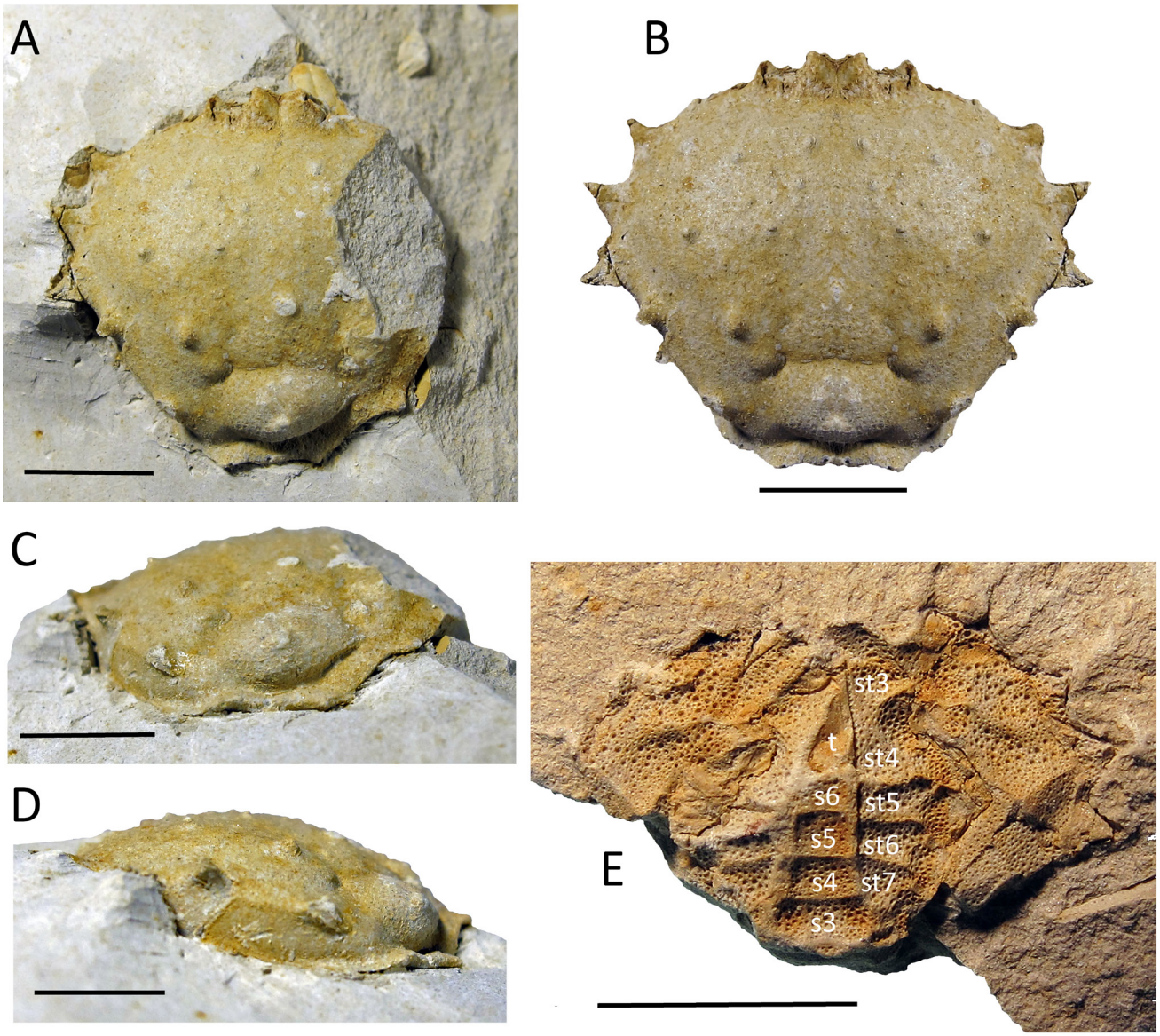

Fig. 2. *Iphiculus eliasi* Hyžný & Gross, 2016. A-D, MGB 89842 from the Langhian of Vilafranca del Penedès (Catalonia); A: dorsal view; B: dorsal view (digital reconstruction); C: posterior view, closeup of posterior part of carapace; D: left lateral view. E, MGB 89843 (male) from the Langhian of Vilafranca del Penedès (Catalonia): ventral view. Abbreviations: st = thoracic sternites; s = pleonal somites; t = telson. Scale bars equal 5 mm.

missing). Carapace surface covered evenly with large rounded tubercles; hepatic region with 1 tubercle; protogastric region with one pair of transversely aligned tubercles in each lobe, and 2 tubercles aligned at the basis of mesogastric region, branchial region with 3 tubercles. Carapace grooves absent in anterior carapace portion, well developed in posterior carapace portion. Gastric region large, indistinctly demarcated with grooves. Cardiac region ovate in outline, strongly arched. Branchial regions broad. Intestinal region narrow. Thoracic sternum relatively wide, maximum width at level of fifth thoracic sternite, sterno-pleonal cavity reaching end of sternite 3; sternite 3 subtriangular, inverted; sternite 4 subtrapezoidal, wider than sternite 3; sternite

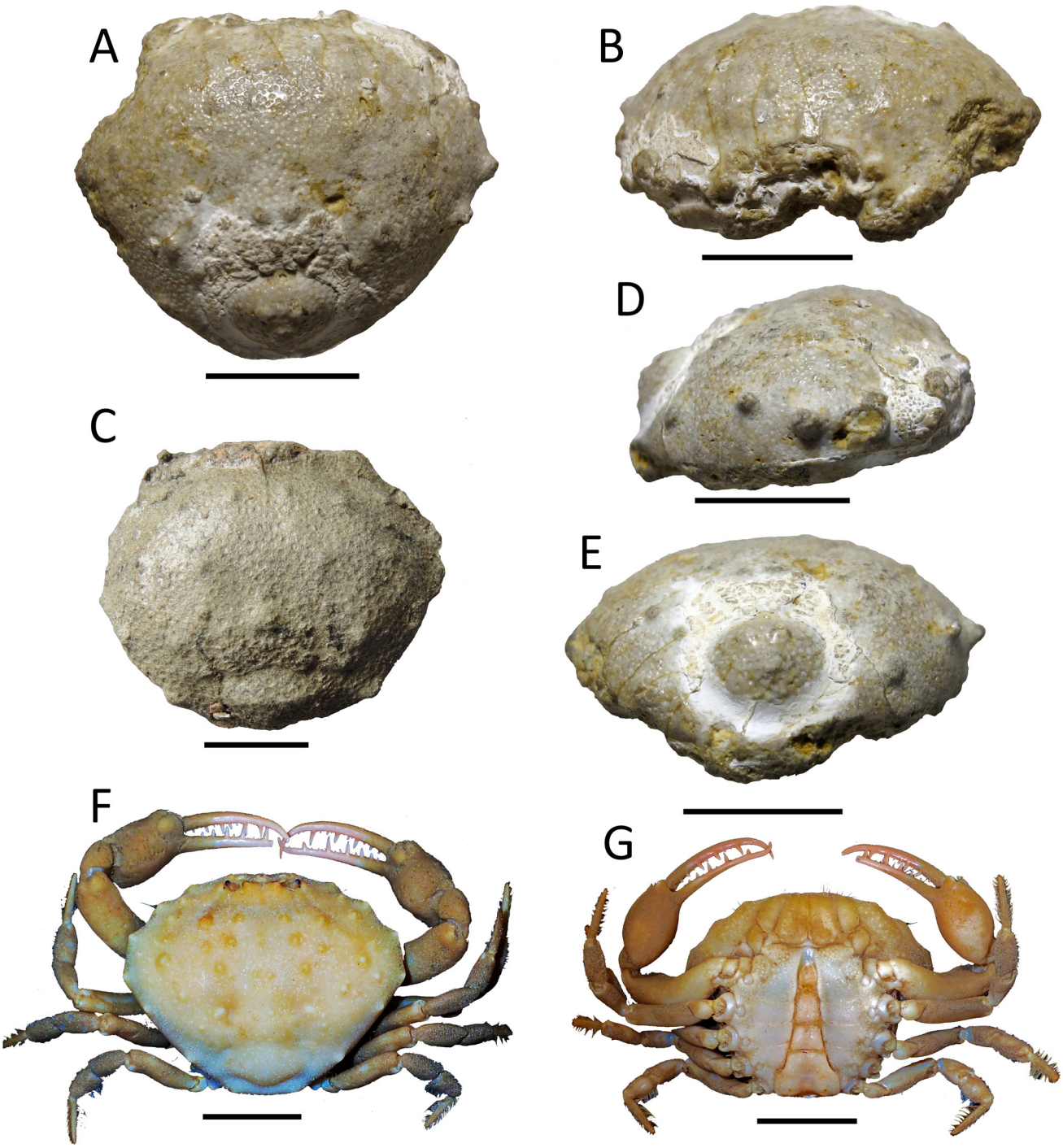

Fig. 3. *Iphiculus eliasi* Hyzny & Gross, 2016 in *I. convexus Ihle*, 1918 . A, B, D, E: *Iphiculus eliasi* Hyzny & Gross.: MV15169, from the Langhian of Santa Margarida i Els Monjos (Catalonia); A: dorsal view; B: frontal view; D: right lateral view; E: posterior view. C: holotype UMJGP 75.612, from the lower Badenian of Wetzelsdorf, Austria; C: dorsal view. F, G, *Iphiculus convexus* Ihle, 1918, ZRC 2009.0462 (male specimen from Vanuatu); F: dorsal view; G: ventral view. Scale bars equal 5 mm, except for F and G in which it is 10 mm. Photographs of F-G by P.K.L. Ng.

5 subrectangular transversely elongate; sternite 6 subtrapezoidal transversely elongate; sternite 7 subtrapezoidal, directed posteriorly, shorter than sternite 6. Episternite 4 laterally directed; episternites 5-6-7 progressively posteriorly directed. Suture 3/4 laterally visible, opened; sutures 4/5, 5/6 and 6/7 apparently complete. Male pleon extremely narrow, inverted T-shaped, all pleonal somites free; somite 3 being widest, subrectangular transversely elongate; somites 4, 5, and 6 subrectangular, narrowing progressively to the telson; telson subtriangular longitudinally elongate, sharp pointed, twice as long as somite 6. Pterygostome subtrapezoidal. All ventral surface, sternum, pleon, pterygostome and branchiostegite densely granulate. Exognath of third maxilliped elongate, inner side smooth.

Remarks: Hyžný & Gross (2016) described a new species, *Iphiculus eliasi* (Fig. 3C), from the Middle Miocene of Austria (Steiermark). In their paper, Hyžný & Gross (2016, p. 268) pointed out that a leucosioid found in outcrops at Santa Margarida i Els Monjos (Alt Penedès, Catalonia), described and figured first as "Iliinae, Ebaliinae?" by Via (1941, p. 68-69, pl. 10, fig. 75) and subsequently as "*Randallia*? sp." by Müller (1993, p. 12, figs. 5M-N), could be an iphiculid related to *I. eliasi*. Access to this sample of "*Randallia* sp.?" (Fig. 3A, B, D, E), housed in the Museum of Vilafranca (now Vinseum), has now allowed to conclude that, despite the different types of preservation as a result of different lithologies at outcrops, it is conspecific with the Vilafranca specimens and likewise, both specimens are also conspecific with the Austrian one described by Hyžný & Gross (2016) as *Iphiculus eliasi* (see Hyžný & Gross, 2016, p. 268). Additionally, a small counterpart of a well-preserved male venter, recovered in the Vilafranca outcrop, is available (Fig. 2E). This exhibits the main diagnostic characters of the Iphiculidae, such as a very narrow male pleon with all somites free (Figs. 2E, 3G; Ng et al., 2008, p. 87); this allows us to attribute it to a single iphiculid known from the area, *I. eliasi*.

A carapace preserved in dorsal aspect from the Middle Miocene of Quinta da Farinheira, Lisboa (Portugal), described and figured by Veiga Ferreira (1965, p. 142-143, pl. 2, 8) as *Petrochirus* cf. *priscus* Brocchi, 1883, does not represent part of a hermit crab, but rather the carapace of a leucosioid crab. Actually, the material is considered conspecific with *Iphiculus eliasi*, thus widening the distribution of the species further to the west.

Discussion

Müller (1993, p. 5, table 1) already pointed out the affinities between the Langhian and Serravallian decapod crustacean assemblages of the westernmost Proto-Mediterranean and roughly coeval Badenian assemblages of the Central Paratethys. Although he concluded that only 9 of 22 identified Miocene species of Catalonia were reported also in the Central Paratethys, recent reports present further taxa that are present in both areas (Díaz-Medina et al., 2018; herein). Nevertheless, some Iberian occurrences are slightly younger, being of Late Miocene age (Díaz-Medina et al., 2017).

The presence of *Iphiculus eliasi* in the northeast and southwest of Iberian Peninsula represents the westernmost (fossil) record for the genus and for the family. Extant representatives of the family Iphiculidae are found mainly in the Indo-West Pacific, in a depth range of 11 to 177 m (Chen, 1989; Chen & Sun, 2002), preferring muddy and sandy bottoms (Galil & Ng, 2007), similar environments to that inhabited by *Iphiculus eliasi*.

Conclusions

The ventral counterpart, preserving diagnostic sternal and pleonal characters, allows to emend the original description of *Iphiculus eliasi* and further corroborate its original systematic assignment. Its presence in the Middle Miocene of the northeastern coast of the Iberian Peninsula, as well as along the southwestern Iberian coast (Portugal), supports the circum-Mediterranean distribution of decapod crustacean assemblages during that time interval (Gašparič & Ossó, 2016; Hyžný & Gross, 2016; Díaz-Medina et al., 2018 and references therein).

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References

Adams, A. & White, A. 1849: Crustacea, Part II. In: Adams, A. (ed.): Zoology of the Voyage of H. M. S. Samarang; under the command of Captain Sir Edward Belcher, C.B., F.R.A.S., F.G.S., during the years 1843-1846. Reeve, Benham & Reeve, London: 33-67, pls. 7-13.

Alcock, A. 1896: Materials for a carcinological fauna of India. No. 2. The Brachyura Oxystoma. Journal of the Asiatic Society of Bengal, 65: 134-296, pls. 6-8.

Almera, J. 1896: Reconocimiento del primer piso Mediterráneo en el Panadés. Memorias de la Academia de Ciencias y Artes, 1, 20: 22 p.

Artal, P. 2008: *Uca miocenica* (Crustacea, Decapoda), nueva especie del Mioceno de la Provincia de Barcelona (Cataluña, España). Scripta Musei Geologici Seminarii Barcinonensis, Series Palaeontológica, 6: 2-10.

Bartrina, M.T., Cabrera, L., Jurado, M.J., Guimerà, J. & Roca, E. 1992: Evolution of the central Catalan margin of the Valencia trough (western Mediterranean). Tectonophysics, 203/1-4: 219-247. https://doi.org/10.1016/0040-1951(92)90225-U

Brocchi, P. 1883: Notes sur les Crustacés fossiles des terres tertiaires de la Hongrie. Annales des Sciences Géologiques, 2/14: 1-8.

Cabrera, L., Calvet, F., Guimera, J. & Permanyer, A. 1991: El registro sedimentario miocénico en los semigrabens del Vallés-Penedés y de El Camp: organización secuencial y relaciones tectónica sedimentación. In: F. Colombo (ed.): Libro-Guía Excursión nº 4 del I Congreso del Grupo Español del Terciario. Vic, Barcelona.

Cabrera, L. & Calvet, F. 1996: Onshore Neogene record in NE Spain: Vallès-Penedès and El Camp half-grabens (NW Mediterranean). In: P.F. Friend & C.J. Dabrio (eds.): Tertiary basins of Spain: the stratigraphic record of crustal kinematics, 97-105. https://doi.org/10.1017/CBO9780511524851.017

Cabrera, L., Roca, E., Garcés, M. & Porta, J. de 2004: Estratigrafía y evolución tectono-sedimentaria oligocena superior-neógena del sector central del margen catalán (Cadena Costero-Catalana. In: J.A. Vera (ed.): Geología de España, Madrid: SGE-IGME: 569-573.

Casanovas-Vilar, I., Garcés, M., Van Dam, J., García-Paredes, I., Robles, J. M. & Alba, D. M. 2016: An updated biostratigraphy for the late Aragonian and Vallesian of the Vallès-Penedès basin (Catalonia). Geologica Acta, 14/3: 195-217. https://doi.org/10.1344/GeologicaActa2016.14.3.1

Chen, H. 1989: Leucosiidae (Crustacea, Brachyura). In: Forest J. (ed.): Résultats des Campagnes MUSORSTOM, Mémoires du Muséum national d'Histoire naturelle Paris, 5/A144: 181-263.

Chen, H. & Sun, H. 2002: Brachyura: marine primitive crabs. In: Fauna Sinica Invertebrata: Arthropoda: Crustacea. Science Press, Beijing, 30/13: 597 p.

Díaz-Medina, G., Hyžný, M. & Klompmaker, A. A. 2017: A lithostratigraphic and palaeoenvironmental framework for the Late Miocene El Caracolar section (Granada Basin, Betic Cordillera, Spain) and description of decapod crustaceans. Geobios, 50: 173-195.

Díaz-Medina, G., Ossó, À. & Hyžný, M. 2018: A middle Miocene decapod faunule from Granada (Spain), with remarks on distribution pattern of the crab *Portunus monspeliensis*. Neues Jahrbuch für Geologie und Paläontologie Abhandlungen, 288: 129-141.

Galil, B.S. & Ng, P.K. 2007: Leucosiid crabs from Panglao, Philippines, with descriptions of three new species (Crustacea: Decapoda: Brachyura). The Raffles Bulletin of Zoology, 16: 79-94.

Garassino, A., Artal, P. & Pasini, G. 2009: *Upogebia miocenica* n. sp. (Crustacea, Thalassinidea, Upogebiidae) from the Miocene of Catalonia (Spain). Atti della Società italiana di Scienze naturali e del Museo civico di Storia naturale in Milano, 150/1: 61-68.

Gašparič, R. & Ossó, À. 2016: New reports of decapod *Portunus monspeliensis* A. Milne Edwards, 1860 from Miocene beds of eastern Slovenia with notes on palaeoecology and palaeobiogeography. Geologija 59/1, 55-66. https://doi.org/10.5474/geologija.2016.005

Guinot, D. 1977: Propositions pour une nouvelle classification des Crustacé Décapodes Brachyoures. Comptes rendus hebdomadaires des séances de l'Académie des sciences, Série D, 285: 1049-1052.

Hyžný, M. & Gross, M. 2016: A new iphiculid crab (Crustacea, Brachyura, Leucosioidea) from the Middle Miocene of Austria, with notes on palaeobiogeography of *Iphiculus*. Zootaxa 4179/2: 263-270. https://doi.org/10.11646/zootaxa.4179.2.6

Ihle, J.E.W. 1918: Die Decapoda Brachyura der Siboga-Expedition. III. Oxystomata: Calappidae, Leucosiidae, Raninidae. Siboga Expeditie Monographie, 39/b2: 159-322, figs. 78-148

Latreille, P.A. 1802-1803: Histoire naturelle, générale et particulière, des Crustacés et des Insectes. Vol. 3. F. Dufart, Paris, 468 p.

Macpherson, I. 1994: Revisión bioestratigráfica de los depósitos marinos del Mioceno medio en la cuenca del Penedés. Acta Geológica Hispánica, 29/2: 123-132.

Milne-Edwards, A. 1860: Histoire des Crustacés podophthalmaires fossiles et Monographie des Décapodes Macroures de la famille des Thalassiniens. Annales des Sciences Naturelles, 4e série, 14: 129-357.

Müller, P. 1993: Neogene decapod crustaceans from Catalonia. Scripta Musei Geologici Seminarii Barcinonensis, 225: 1-39.

Ng, P.K.L., Guinot, D. & Davie, P.J.F. 2008: Systema Brachyurorum: Part I. An annotated checklist of extant brachyuran crabs of the world. Raffles Bulletin of Zoology, 17: 1-286.

Ossó, À. 2010: Els fòssils al Camp de Tarragona. Kesse, Dossier, 43: 4-10.

Permanyer, A. 1982: Sedimentologia i diagènesi dels esculls miocens de la conca del Penedès. Tesi doctoral. Departament de Petrologia i Geoquímica. Universitat Barcelona: 545 p.

Roca, E., Sans, M., Cabrera, L. & Marzo, M. 1999: Oligocene to Middle Miocene evolution of the central Catalan margin (northwestern Mediterranean). Tectonophysics, 315(1/4): 209-233. https://doi.org/10.1016/S0040-1951(99)00289-9

Roca, E., Frizon de Lamotte, D., Mauffret, A., Bracène, R., Vergés, J., Benaouali, N., Fernàndez, M., Muñoz, J.A. & Zeyen, H. 2004 : TRANSMED Transect II. In: Cavazza, W., Roure, F., Spakman, W., Stampfli, G.M. & Ziegler, P. (eds.): The TRANSMED Atlas- The Mediterranean Region from Crust to Mantle. Springer, Berlin Heidelberg.

Saint-Laurent, M. de 1980: Sur la classification et la phylogénie des Crustacés Décapodes Brachyoures. I. Podotremata Guinot, 1977, et Eubrachyura sect. nov. Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences, Paris, Série D, 290: 1265-1268.

Samouelle, G. 1819: The entomologist's useful compendium; or an introduction to the knowledge of British insects, comprising the best means of obtaining and preserving them, and a description of the apparatus generally used; together with the genera of Linné, and the modern method of arranging the classes Crustacea, Myriapoda, Spiders, Mites and Insects, from their affinities and structure, according to the views of Dr. Leach. Also, an explanation of the terms used in entomology; a calendar of the times of appearance and usual situations of near 3,000 species of British insects; with instructions for collecting and fitting up objects for the microscope. Printed for Thomas Boys, London : 496 p.

Solé, J. & Via, L. 1989: Crustacis Decàpodes fossils dels Països Catalans. Batalleria, 2: 23-42.

Veiga Ferreira, O. da 1965: Nova contribiçao para o conhecimento dos Malacostráceos do Miocénico Marinho de Portugal. Comunicações dos Serviços Geologicos de Portugal, 48: 5-19.

Via, L. 1932: Els crancs fossils del Terciari de Catalunya. Butlletí de la Institució Catalana d'Història Natural, 32/4: 1-16.

Vía, L. 1941: Los cancrejos fósiles de Cataluña. Boletín del Instituto Geológico de España, 55: 55-128.

Via, L. 1966: *Pinnixa* (*Palaeopinnixa) mytilicola*, nuevo braquiuro fósil, en el mioceno marino del Vallés (Barcelona). Acta Geológica Hispánica, 1/4: 1-4.