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ON A NEW PYGASTERID (ECHINOIDEA) FROM THE JURASSIC
(MIDDLE LIAS) OF NEVADA, U. S. A.

Abstract. — *Plesiechinus hawkinsi* n. sp. from the Middle Lias of Nevada, U. S. A., the oldest and most primitive representative of an irregular echinoid family of the Pygasteridae Lambert, 1900, displays a "regular" apical system with genital 5 perforate. Crenulate tubercles in the new species contest earlier opinions on the derivation of pygasterids from echinoids with smooth tubercles.

INTRODUCTION

Among the known families of irregular echinoids, the Pygasteridae distinguish themselves by their morphology so similar to that of regular echinoids that only their incomplete apical system (the lack of genital 5) and an elongate periproct partly removed towards interambulacrum 5 allow one to assign these forms to the irregulars. One could expect, therefore, that exactly this group would facilitate tracing the most primitive stages of the formation of the Irregularia, a process in which changes in the structure of apical system undoubtedly preceded all other processes such as e.g. a loss (in some of the irregulars) of jaw-apparatus, etc.

The state of knowledge of the morphology of the Pygasteridae is, however, insufficient and virtually remains at the same level which reached several scores of years ago. Recently, an essential progress was reached in the recognition of the Pygasteridae owing to Melville's (1961) studies which, however, concerned mainly the structure of the Aristotle's lantern.

The fact that the structure of apical system in the Pygasteridae is rarely preserved, is undoubtedly the reason why its knowledge is so poor. This primarily concerns primitive representatives of this family. It should be emphasized that the pygasterids belong to a group not numerous represented in both the species and individuals.

The Pygasteridae are first recorded in the Lias and only *Pygaster reynesi* Desor, 1868 is known definitely from that period. Not a single

element of apical system is, however, preserved in this material. *Pygaster microstoma*, described by Lambert (1933, p. 54, Pl. 3, Fig. 12) from the Toarcian of Morocco, after the present writer's study on the holotype from Lambert's Collection (Paris) turned out to be a representative of the family Galeropygidae¹. Another Liassic species, *Pygaster daguini* Lambert, 1931, from the Lower Domerian of Morocco, is based on such a fragmentary specimen that there is no certainty that it is a representative of the Pygasteridae. Probably Lambert's description concerns a different specimen than that in Lambert's Collection, but the search for the appropriate specimen was unsuccessful.

In the light of these scant data on the oldest pygasterids it is understandable why so much interest was aroused by Hawkins' (1943, p. LIX) communication on the existence of "... a series of an undescribed species of *Plesiechinus* from Middle Lias of Nevada in which the two smallest specimens appear to have a slender rim between the periproct and the interambulacrum, while all of the larger ones (several of which retain the apical plates) are unequivocal pygasterids in every way". Mortensen (1948, p. 20) was informed by Hawkins that this collection has not as yet been elaborated but that, in the last-named author's opinion, the species involved was closely related to *Plesiechinus ornatus* (Buckman). Unfortunately, the material has never been studied, since, evacuated during the war, the collection was probably lost. Some years ago, Hawkins received another, small collection of the pygasterids from the Lias of Nevada, but he did not describe them before his death.

By courtesy of Professor W. J. Durham (University of California, Berkeley), this material has been sent in for the present writer's elaboration for which she extends her thanks to him.

The work has been prepared at the Polish Academy of Sciences, Palaeozoological Institute, Warsaw. The writer's heartfelt gratitude is due to Professor R. Kozłowski for a critical review of the manuscript. Photographs were taken by Miss M. Czarnocka and illustrations drawn in ink by Mrs K. Budzyńska, both from the same Institute.

The collection described is the property of the University of California, Museum of Paleontology, Berkeley.

Characteristics of the material

The material, described in the present paper, comes from the State of Nevada's Sunrise formation whose entire thickness amounts to about 1,200 feet (approx. 365 m). According to Muller and Ferguson (1936, p. 249), this

¹ This is undoubtedly a representative of a new genus, which will be described in a separate paper.

formation includes beds which, on the basis of fossils it contains, may be correlated with Hettangian, Sinemurian and maybe also Charmoutian of the European Lias. The pygasterids were found in New York Canyon, Gabbs Valley Range, a type locality of Sunrise formation, in beds laying 15–30 feet below the *Eoderoceras* zone², assigned by Arkel (1956, p. 556) to the Upper Sinemurian. Consequently, the American species is the oldest known representative of the family Pygasteridae. *P. reynesi*, another Liassic pygasterid, comes from the Domerian of France.

The collection from Nevada consists of five, badly weathered specimens, two of which permit the writer to make observations giving a fairly important data concerning the morphology of this little known group of irregular echinoids.

NEW DATA ON MORPHOLOGY

The Liassic pygasterids from Nevada do not differ in several characters from typical representatives of this group (comp. Systematic Part), but there are two elements of their morphology which require a more detailed discussion.

Apical system. — A complete apical system has not been preserved on any of the specimens under study, but the holotype (No. D-15) supplied important data concerning the structure of this element of test (Fig. 1A). The most important is the presence of genital 5 with a distinct genital pore. This indicates that this plate fulfilled its function. The pore constituted an outlet of the 5th, undoubtedly still functioning, gonad. The remaining genital plates, in particular the 1 and 4, have a rather peculiar appearance, being very narrow. It is difficult to determine to what extent their present appearance corresponds to their original state, for the test is fairly strongly weathered and it is quite likely that the surface of these plates was originally much larger. The madreporite, preserved on this same specimen, is fairly large. Hawkins, who observed the apical system on several specimens, did not mention anything peculiar in the appearance of the genital plates.

The apical system in the new species is very slightly elongated, mostly as a result of the fact that the periproct is only to a small degree removed towards interambulacrum 5.

The apical system of *Pl. hawkinsi* n. sp. compared with that of regular echinoids, showing the tendency to the exocyclisme (Fig. 1B), displays such a distinct similarity that it is impossible to mark out any boundary separating the two structures. Their identity is particularly emphasized by

² Professor J. W. Durham kindly informed me (in the letter of Dec. 5, 1969) that "Professor Muller is responsible for the collection of the specimens as well as the stratigraphy and age assignment".

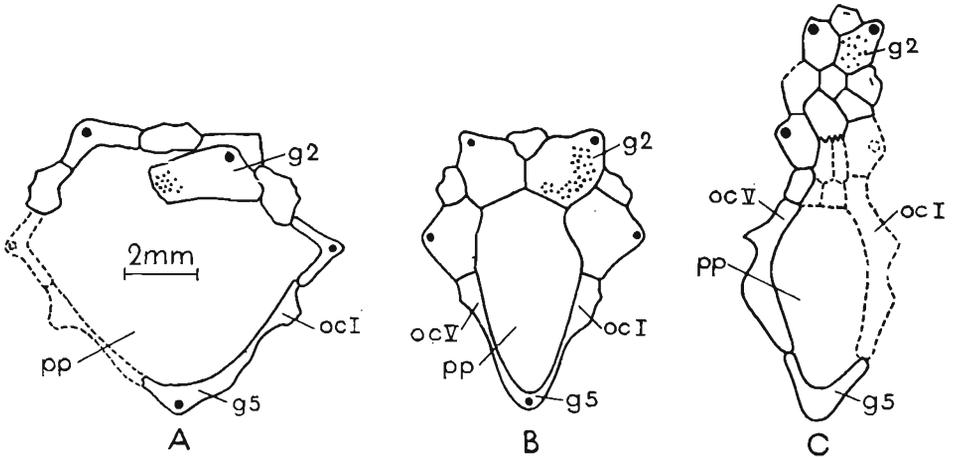


Fig. 1.—Apical systems: *A* *Plesiechinus hawkinsi* n. sp., Sinemurian, Sunrise formation, Nevada, No. D-15; *B* *Acrosalenia somaliensis*, Bathonian, after Maccagno (1947, Fig. 3); *C* *Hyboclypus caudatus*, Bajocian, after Jesionek-Szymańska (1963, Pl. 2, Fig. 3). In *A* and *B*—sutures between posterior oculars and genital 5 not marked.

the presence in *Pl. hawkinsi* n. sp. of a genital pore in the genital 5, which is not recorded in any of the remaining most primitive families of irregular echinoids. Among them the relatively most primitive condition is observed in *Hyboclypus caudatus*, a representative of the Galeropygidae (Fig. 1C). In this form, genital 5 is still fairly well developed, but no genital pore occurs in it. Apparently, the atrophy of the 5th gonad preceded the process of disappearance of a corresponding plate.

The endocyclic type of apical system, combined with a typically regular structure of the test in *Pl. hawkinsi* n. sp., cause that were the further evolution stages of pygasterids not known, this species would undoubtedly be assigned to regular echinoids with the tendency to exocyclisme. Thus, the species under study approaches to the highest degree the boundary between the regular and irregular type. The lack of well preserved adult individuals of *Pl. hawkinsi* n. sp. does not allow one to answer the question whether the crossing of this boundary takes place already in this species. The conclusion could be drawn from Hawkins' observations (cf. quotation, p. 412) that in larger (adult) individuals the periproct is no more surrounded by a set of plates of apical system. To explain this problem it is necessary to have a more extensive material, containing juvenile and adult forms preserved as completely as possible.

Tuberculation.—Among previous authors, there was a considerable divergence of opinions on the type of tubercles (smooth or crenulate) in the family Pygasteridae (Lambert, 1931, p. 18). However, Cotteau's (1867–1874) and Wright's (1857–1878) authority was a final factor that established the opinion that the pygasterid tubercles were smooth. This opinion was accepted by Lambert (1931) who suggested that a poorly preserved

material was the source of a false information and that what the authors and illustrators took for crenulation, were actually pits resulting from weathering. Lambert's emphatic attack of the existence of crenulation seemed to result mostly from theoretical premises. According to Lambert (*l. c.*, pp. 18-19), the loss of crenulation was a progressive character and, since he derived the Pygasteridae from the Pedinidae (tubercles smooth) he did not admit the presence of crenulation in Pygasteridae.

Because the character of tubercles played a considerable role in the considerations on the phylogeny and systematic position of the Pygasteridae, it is worth citing the results of studies on this problem.

The present writer's studies of specimens of the Pygasteridae from the French and British collections have shown the presence of a more or less distinct crenulation in *Plesiechinus ornatus* (Buckman) from the Bajocian of England and in *Pygaster trigeri* Cotteau from the Bathonian of France (Pl. II, Fig. 3). In these two species, the crenulate tubercles occur on both the ambulacral and interambulacral plates. It is also worth mentioning that illustrator of *Pygaster semisulcatus* Agassiz (= *Plesiechinus ornatus*) (1867-74, Pl. 118, Fig. 3) and *Pygaster trigeri* (*l. c.*, Pl. 121, Fig. 5), marked crenulations in these pygasterids, while Cotteau himself consistently emphasized in the description that the tubercles in the Pygasteridae were smooth.

The presence of a more or less distinct crenulations in the species referred to above clearly indicates that this is a disappearing character. It might be expected that, in more primitive representatives of this family, crenulation occurred on all tubercles. This supposition was fully confirmed by observations of *Pl. hawkinsi* n. sp., in which all tubercles studied on both ambulacral (Pl. II, Fig. 2b) and interambulacral plates are conspicuously crenulate. The presence of this primitive character is in conformity with the Liassic age of the species under study.

New data on the morphology of primitive pygasterids, resulting from the studies on the collection from Nevada, will undoubtedly be of a considerable importance to the revision of views on the phylogeny of this family. This problem will be analysed in a more extensive elaboration, devoted to the primitive representatives of the families Pygasteridae and Holoctypidae, now being prepared by the present writer.

SYSTEMATIC PART

Family **Pygasteridae** Lambret, 1900

Genus *Plesiechinus* Pomel, 1883

Type species: *Plesiechinus macrostomus* (Wright)

The genus *Plesiechinus*, erected by Pomel mostly on the basis of the structure of apical system, has not been accepted by all other authors. Lambert (1924, pp. 610-611) particularly opposed acknowledging it as an

independent taxon, and Beurlen (1933, p. 11) considered it to be a subgenus. The recognition of the genus *Plesiechinus* will arouse doubt as long as no materials with the apical system preserved are found. Due to degree of the destruction of the plates of most of apical system, the collection from the Lias of Nevada also does not solve this problem.

Plesiechinus hawkinsi n. sp.

(Fig. 1A; Pls. I, II, Figs. 1-2)

Type specimen: No. D-15 (Fig. 1A; Pl. I, Fig. 1; Pl. II, Fig. 1).

Type locality: New York Canyon, Gabbs Valley Range, Nye County, Nevada, U.S.A.

Type horizon: 15-30 feet below the *Eoderoceras* zone, Sunrise formation (Sinemurian).

Derivation of the name: *hawkinsi*—in honour of the late Professor H. L. Hawkins who first recognized the value of this material.

Diagnosis. — Pygasterid with a very short periproct completely inside (only in juvenile forms?) the apical system; genital 5 perforate; tubercles crenulate.

Material. — Five individuals, of which only one is fairly well preserved.

Dimensions — see Table below.

Description. — Test slightly pentagonal. Adapical side strongly convex, the height of the test exceeding a half of its length; the largest height is recorded slightly posteriorly, outside the middle of test. Oral side flat, near peristome markedly depressed.

Species	Stage	No.	Length (in mm)	Width/ length	Height/ length	Remarks
<i>Plesiechinus hawkinsi</i> n. sp.	Sinemurian	UC D-50	25.2	—	—	Collection of University of California, Museum of Paleontology
		UC D-15	33.7	1.01	0.51	
		UC 1— 07—010	46.2	1.1	0.56	
<i>Pygaster reynesi</i> Desor, 1868	Dome- rian	—	30.0	1.0	0.46	from Cotteau (1867—1874),
		—	38.0	1.0	0.40	from Lambert (1924)
<i>Plesiechinus ornatus</i> (Buckman)	Bajocian	E 75 254	18.6	0.95	0.48	Collection of British Museum
		E 75 256	43.9	1.00	0.38	
		E 75 248	56.2	1.02	0.37	

Apical system endocyclic. Genital 1 and 3 very narrow; madreporite large, subrectangular; genital 4 destroyed. All ocular plates (ocular V absent) are large and insert, but it is unknown whether, on account of a considerable degree of destruction, the picture now observed is true. Ocular I very narrow, elongated posteriorly, where it contacts genital 5. The suture between the two plates is imperceptible. Periproct relatively short, only slightly encroaching the interambulacrum 5.

Ambulacra fairly wide on the adapical side and distinctly narrowed near the peristome. They are built of low plates. About 4 to 5 ambulacral plates fall to one interambulacral plate on the adapical side.

On the adapical side, ambulacral pores are fairly large and differentiated, inner small, round and outer fairly large, oval. On the oral side ambulacral pores are very small.

Peristome not very large, situated centrally in a distinct depression of the test. Gill slits small.

Tuberculation very characteristic of the species, both ambulacral and interambulacral tubercles are conspicuously crenulate.

Remarks. — The present writer's studies have confirmed Hawkins' suggestions (in Mortensen, 1948, p. 20) that the new species is to the greatest extent related to *Plesiechinus ornatus* (Buckman), from which it, however, differs in the size and proportion of test (see Table above), development of apical system and periproct. In *Pl. ornatus* a relatively large periproct strongly encroaches the interambulacral 5 (even in the smallest specimens) and it is most likely that the apical system in this species was already exocyclic. The new species also differs from *Pl. reynesi* from the Domerian of France in the proportions of test (see Table above) and considerably smaller degree of development of periproct. The apical system of *Pl. reynesi* has not been found, but its large periproct indicates that, as concerns the stage of evolution of apical system, the new species is much more primitive.

Occurrence. — So far known only from the Sinemurian of Sunrise formation, Nevada, U.S.A.

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WANDA JESIONEK-SZYMAŃSKA

O NOWYM PRZEDSTAWICIELU RODZINY PYGASTERIDAE LAMBERT, 1900
(ECHINOIDEA) Z LIASU STANU NEVADA (U.S.A.)

Streszczenie

Plesiechinus hawkinsi n. sp. z liasu (sinemuru) stanu Nevada, najstarszy przedstawiciel nieregularnych jeżowców z rodziny Pygasteridae, charakteryzuje się szeregiem prymitywnych cech. Peryprokt, bardzo krótki i tylko nieznacznie wcięty w 5-ty interambulakr, znajduje się całkowicie w obrębie tarczy szczytowej, ograniczony od tyłu 5-tą płytką genitalną z otworem genitalnym. Całość tej struktury nie różni się niczym od tarczy szczytowej jeżowców regularnych, wykazujących tendencję do nieregularności.

Obecność u *Pl. hawkinsi* n. sp. brodawek krenulowanych przeczy dotychczasowym poglądom, wywodzącym Pygasteridae z przodków o brodawkach niekrenulowanych.

ВАНДА ЕСЕНЭК-ШИМАНЬСКА

О НОВОМ ПРЕДСТАВИТЕЛЕ СЕМЕЙСТВА PYGASTERIDAE LAMBERT, 1900
(ECHINOIDEA) ИЗ ЛЕЙАСА ШТАТА НЕВАДА (США)

Резюме

Plesiechinus hawkinsi n. sp. из лейаса (синемюрского яруса) штата Невада, самый древний представитель неправильных морских ежей семейства Pygasteridae, характеризуется рядом примитивных признаков. Очень короткий и только в незначительной степени врезанный в 5 интерамбулак перипрокт находится полностью в пределах вершинного щита, сзади ограниченный пятой генитальной пластинкой с порой. Эта структура ничем не отличается от вершинного щита правильных морских ежей, проявляющих тенденцию к неправильности.

Присутствие кренулированных туберкул у *Plesiechinus hawkinsi* n. sp. противоречит принятым до сих пор взглядам о происхождении Pygasteridae от предков с некренулированными туберкулами.

PLATES

Plate I

Plesiechinus hawkinsi n. sp.
Nevada, Sunrise formation, Sinemurian

Fig. 1. *a* Adapical view, *b* adoral view, *c* side view, holotype, No. D-15; $\times 2$.
Fig. 2. Adapical view, No. 1-0-7-010; $\times 1.3$.



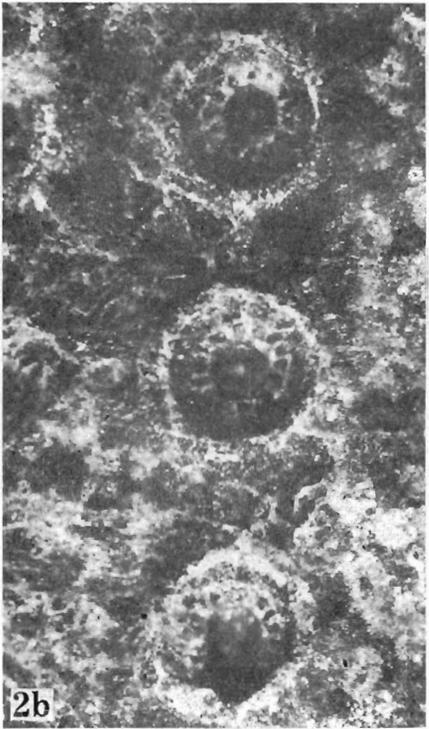
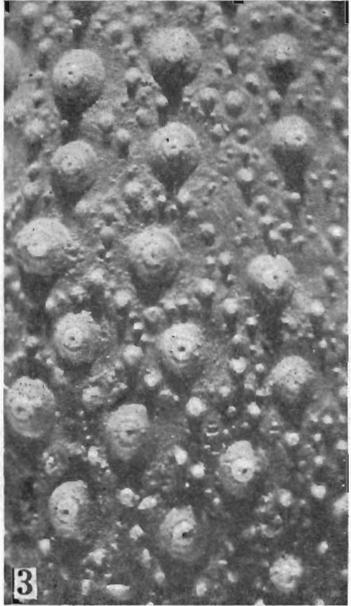


Plate II

Plesiechinus hawkinsi n. sp.
Nevada, Sunrise formation, Sinemurian

Fig. 1. Apical system, holotype, No. D-15; $\times 6$.

Fig. 2. *a* Portion of ambulacrum V, No. 1-0-7-010; $\times 10$; *b* enlarged tubercles of ambulacrum V of same specimen, $\times 13$.

Pygaster trigeri Cotteau
Ranville (Calvados), Bathonian, from Cotteau Collection (Orsay)

Fig. 3. Portion of interambulacrum 5 near the ambitus, tubercles crenulate; $\times 4$
(Photo D. Serrette, Mus. Hist. Nat., Paris).