WANDA JESIONEK-SZYMAŃSKA

REMARKS ON THE STRUCTURE OF THE APICAL SYSTEM OF IRREGULAR ECHINOIDS

Abstract. — The author presents the results of an analysis of the test in *Pygomalus ovalis, P. analis, Pygorhytis ringens, Collyrites* sp. and *Disaster* n. sp. where she has observed the presence of the 5th genital plate. Its displacement is discussed and is shown to be similar to that occurring in the ontogenetic development of *Echinocardium cordatum*. Moreover, in order to homologize the plates of the apical system in echinoids, the writer has also used the crystallographic method, on the ground that the optic axis of the particular plates displays a fairly constant inclination angle. It is supposed that in some genital plates the inclination angle of the optic axis is determined by its position in the remains of the larval skeleton around which these plates arise.

INTRODUCTION

One of the most noteworthy features in echinoid evolution is the migration of the periproct away from the apical system and its progressive shifting towards the oral side. It is generally recognized that in the majority of irregular echinoids this fact is responsible for the disappearance of the 5th genital plate lying in the path of the periproct migration.

An examination of the material, collected between 1954 and 1958 from Bathonian, Callovian and Lower Oxfordian beds in the Kraków-Częstochowa Jurassic, sheds some light on the history of that genital in certain irregular echinoids. The presence in these forms of a vestigial 5th genital has, moreover, been confirmed by crystallographic studies.

The present paper has been prepared at the Palaeozoological Laboratory of the Polish Academy of Sciences in Warsaw, under the guidance of Professor Roman Kozłowski, for whose most valuable and helpful suggestions the writer here wishes to convey her very sincere thanks.

She also thanks Miss St. Mączyńska and Mrs. E. Popiel-Barczyk for the loan of Cretaceous echinoids, much needed as comparative material.

The crystallographic analyses have been carried out by the staff of the Institute of Petrography of the Geological Survey of Poland.

DESCRIPTION

The Disasteridae Gras [1] belong to one of the oldest families of irregular echinoids. Their morphology, however, is far removed from that of their regular ancestors. Among others, this is expressed by the complete separation of the periproct from the apical system. During its backward migration the periproct was accompanied by two ambulacra (I and V) responsible for the disjunct type of the apical system which is an essential character of the Disasteridae.

Representatives of this family have been described in many papers, of which the most comprehensive one is K. Beurlen's monograph (1934).

Nevertheless, a close examination of the test of individuals belonging to genera *Pygorhytis*, *Pygomalus*, *Collyrites* and *Disaster* has revealed the presence at the base of the periproct of a plate so far never described. Here below are data provided by the study of this plate in several representatives of the Disasteridae.

Pygomalus ovalis Leske (Bathonian)

(pl. I, fig. 1, 2)

Plate relatively large, crescentic. Its upper tips are in contact with the elongate ocular plates I and V (not shown in the photo). These 3 elements, surrounding the periproct, are in extremely loose contact with the remaining parts of the test; they are rarely preserved. Hence after they have fallen off, the shape of the periproct, originally pear-like, becomes irregular (pl. I, fig. 2). In thin section under crossed nicols, at full turning of the stage (360°) this plate displays strong, fourfold enlightenment, while the adjacent elements of the test remain dark.

Pygomalus analis Agassiz (Bathonian)

(fig. 1*A*)

Plate considerably smaller than in preceding form, variable in shape. Essentially it is crescentic, but the hollow may be much deeper and the tips longer. Occasionally the two tips are not uniformly elongated (fig. 1*A*). Sometimes, viewed externally, it looks like a narrow list, being then

[1] The writer retains the systematics adopted by T. Mortensen (1950). She does not see sound grounds for the separation of this family into the Disasteridae Gras and Collyritidae d'Orbigny, as suggested by J. W. Durham and R. V. Melville (1957).

very thick. Owing to the coalescence with the adjacent plates it is preserved in all specimens. To ascertain its presence it is necessary to emphasize the sutures by colouring with methyl blue and coating with glycerine. Under crossed nicols this plate behaves as that described above.

Pygorhytis ringens Agassiz (Bathonian and Lower Oxfordian)

(fig. 1*B*)

Plate relatively large, tips not much elongate, rather broad. Not intimately united with the test (clearly delimited), often preserved.

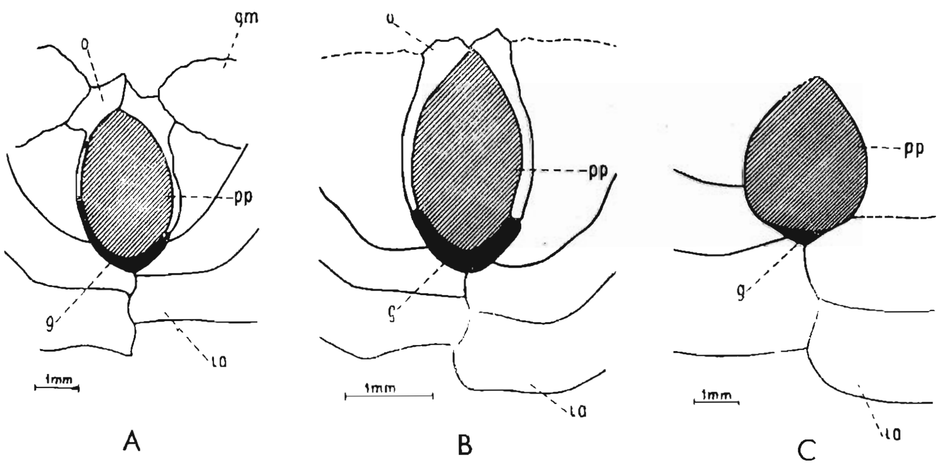


Fig. 1. — A *Pygomalus analis*, B *Pygorhytis ringens*, C *Collyrites* sp.; *am* ambulacrum, *ia* interambulacrum, *g* crescentic plate, *o* ocular plate, *pp* periproct.

Behaviour under crossed nicols as that of the preceding forms. Structure of specimens from Bathonian and Oxfordian is in this respect similar.

Collyrites sp. (Callovian)

(fig. 1C)

Plate extremely small, constituting only a small segment of the periproct rim. Not contacting with the oculars which, in this genus, together with the distal ambulacra, are considerably removed from the periproct. The plate is not readily discernible owing to its coalescence with the surrounding plates. Due to the unsatisfactory state of preservation it has not been possible to ascertain whether it is present in every specimen. As in the previously described specimens, it is clearly visible under crossed nicols.

Disaster n. sp. (Lower Oxfordian)
(pl. I, fig. 3; text-fig. 2)

Plate of variable size, centrally sometimes moderately raised, at others forming only a narrow list (fig. 2*a*). Viewed internally, it has the appearance of a small ridge (fig. 2*b*); when broken off the test, it leaves a distinct

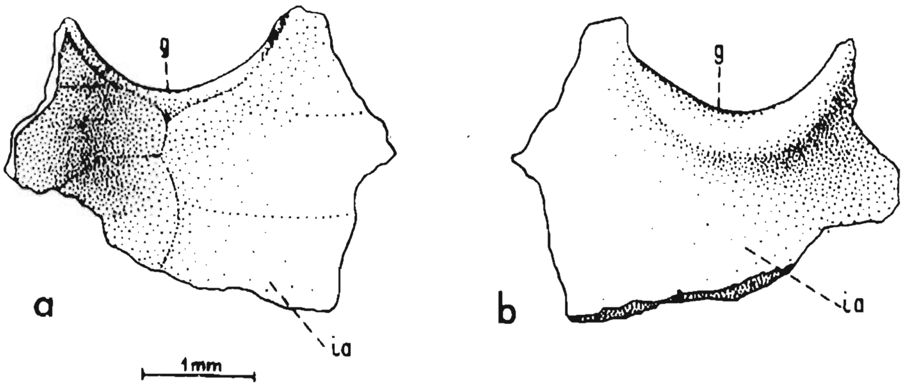


Fig. 2. — *Disaster* n. sp., periproctal area: *a* external view, *b* internal view, *g* crescentic plate, *pp* periproct.

depression on the mould. Strongly united with the test, present in all specimens. Readily discernible under crossed nicols (pl. I, fig. 3).

GENERAL REMARKS

When analysing the structure of the test near the periproct, as seen in the described forms, it may be noted that the considered plate does not belong to the system of interambulacral plates surrounding the periproct. It is symmetrically placed in relation to the suture connecting the two series of the interambulacral plates. Neither it is referable to the periproctal plates since it lies distinctly outside the periproct. In shape it greatly resembles (particularly so in *Pygomalus ovalis*) the 5th genital of such forms, as e.g. *Acrosalenia angularis* (fig. 3*A*). In the latter form we may observe the deformation of the 5th genital in forms with a tendency to periproct migration outside of the apical system.

The history of the 5th genital during further migration of the periproct has not, so far, been studied in fossil specimens. Its presence has not been recorded in the most ancient irregular echinoids, even those where the periproct is in contact with the apical system (Pygasteridae, Galeropygidae). Hence the inference that it had been completely removed by the shifting periproct. Some scanty information on this question is given by

H. L. Hawkins (1943). In a specimen of *Plesiechinus* from the Middle Lias of Nevada he noted the occurrence of a vestigial 5th genital at the base of the periproct in the form "of a slender rim". No further details, however, are available, since this material has not yet been described. The presence of a 5th genital in the Holectypidae and Discoidiidae constitutes a separate problem which will be discussed in a chapter dealing with the crystallographic study of echinoid test.

Some light is shed on the migration mechanism of the periproct, as well as on certain consequences of this phenomenon by studies on the ontogeny of *Echinocardium cordatum* (I. Gordon, 1927). The presence of

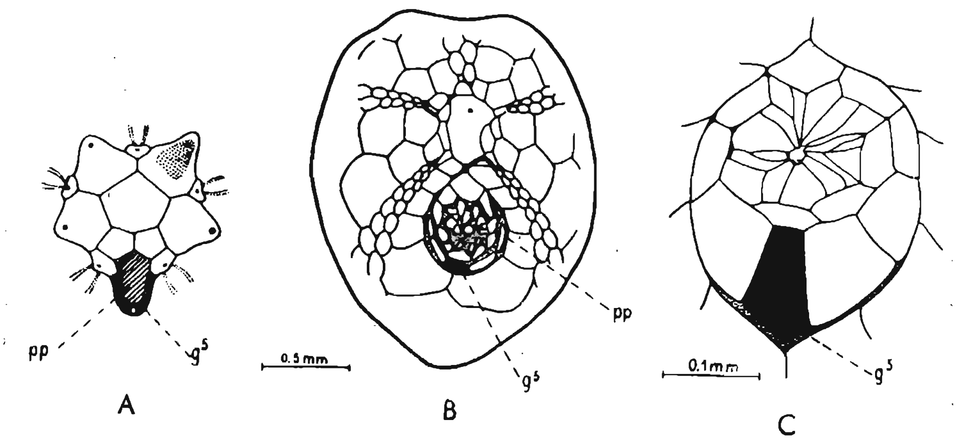


Fig. 3. — A *Acrosalenia angularis* (after Cuénot, 1948), apical system; B *Echinocardium cordatum* (after Gordon, 1927), young specimens; C *Echinocardium cordatum* (after Gordon, 1927), periproct; g_5 5th genital plate, *pp* periproct. All the figures redrawn with some modifications.

five incipient genitals has been ascertained in the early development stages, though four only persist in the apical system of adult individuals. The 5th genital plate is gradually shifted by the periproct which, with individual growth, continues to retreat farther away (fig. 3*B*) from the centre of the apical system where it is initiated. Finally the periproct will occupy a supramarginal position (analogous to that in the above described Disasteridae), while the 5th genital is not eliminated, but becomes one of the periproctal plates (fig. 3*C*). Hence it may be concluded that the periproct migration need not have destroyed the 5th genital, but displaced it and deprived it of its original function.

On these suggestions we may suppose a similar migration mechanism to have operated in the periproct of the Disasteridae. The results of this evolutionary process, however, are different inasmuch that in the Disasteridae the 5th genital did not become one of the periproctals, but was incorporated into the test as an element surrounding the periproct.

On morphological observations supported by embryological data the writer feels justified to recognize the plate noted in *Pygomalus, Pygorhytis, Collyrites* and *Disaster* as the vestigial 5th genital. Crystallographic studies have confirmed this conclusion.

The use of the optical methods in the study of the skeleton of Echinoderms is based on the widely known fact that every one of the skeletal elements is a separate calcite crystal. This has been proved on optical properties and characteristic cleavage. Further confirmation has been provided by X-ray examination (C. D. West, 1937). This particular property of the echinoderm skeleton has, among others, been taken into consideration when studying the skeletons of Ophiuroidea and Crinoidea (S. Becher, 1914). In the case of echinoids the crystallographic orientation was helpful in determining the origin of the particular elements of the lantern of Aristotle (H. L. Hawkins, 1934). The optical properties of the skeleton of echinoderms have proved valuable when tracing the growth stages in representatives of this type of animals. Under crossed nicols the contours of plates are very distinct, facilitating detailed observations.

During examination under crossed nicols of the early growth stages of the skeleton of *Echinus miliaris*, J. Gordon (1926) ascertained that in the apical system of a markedly small individual the 3rd and 5th genitals long remain readily distinguishable by their pale colouration. Without detailed discussion of this feature, she interpreted it as a difference in the texture of plates. Similar observations have been made by that author during the studies on the ontogeny of *Echinocardium cordatum* (1927) when she noted that in young individuals the 3rd genital and the so-called plate Y (subsequently proved to be the 5th genital) are distinctly lighter than the remaining genitals.

On the difference of colouration mentioned by J. Gordon, L. v. Ubisch suitably shaded the plates of the apical system figured by him (1927, p. 555, fig. 13). Similarly as Gordon, Ubisch did not search for the causes of this feature, but only stressed its symmetry in relation to the "Primordialebene" established by him in 1913. Gordon's observations are associated with the orientation of the optic axis in the particular plates of the apical system. This problem has been lately dealt with by Lucas (1953). That author has investigated the genitals of some recent and fossil regular echinoids. Information resulting from his studies may be summarized as follows.

In three genital plates (the so-called *B* group) the optic axes are vertical to the surface, while in the remaining one (group *A*) they are parallel. The composition of the two groups (*A* and *B*) presents two variants, resulting in two types of crystallographic symmetry of the apical system of echinoids.

Type I. Group *B* consisting of the 1st, 2nd and 4th genitals (numbering after Loven), while the 3rd and 5th plates make up group *A*.

This scheme permits the plotting of a plan of the crystallographic symmetry which extends through the IInd ocular and the 4th genital.

Type II. Group *B* consisting of the 1st, 3rd and 4th genitals, while group *A* is made up of the 2nd and 5th plates.

Here the plane of crystallographic symmetry extends through the IVth ocular and the 1st genital.

On these data Lucas has advanced a concept concerning the origin of the apical system in echinoids. This is not mentioned in the present paper since it is outside its scope.

Lucas' method was adapted by A. Devriès (1954) in the study of the apical system of irregular echinoids, particularly those of genus *Hemiaster*. The absence from the apical system of the studied forms of the 5th genital was confirmed by him through optical methods.

RESULTS OF THE AUTHOR'S OBSERVATIONS

By ascertaining the constant position of the optic axis in the particular plates of the apical system, new possibilities have been provided for their homologization. From this standpoint it has been deemed interesting and recommendable to investigate the position of the optic axis in the plate observed in some Disasteridae, which on morphological and embryological observations has been recognized as being the 5th genital, removed from its original position in the apical system by the migrating periproct.

Measurements of the position of the optic axis were taken on universal rotating stage mounted into Row's microscope. Since the maximum deviation of the stage here is 60°, it was not possible to give more accurate results for higher magnitudes of angles. These examinations were made in thin sections, and involved not only the periproctal area, but the apical systems too. Other fossil and recent echinoids were analogously measured for comparative studies.

The obtained results are tabulated on p. 346 (tab. 1).

In items 1-4 measurements concerning the 5th genital are those ascertained in a plate found at the base of the periproct. On item 8, on Gordon's suggestions, one of the periproctal plates has been recognized as the 5th genital plate.

The quoted results only to a certain extent agree with those obtained by Lucas and call for a more detailed discussion.

The apical systems in the examined echinoids belong to type I, differentiated by Lucas, in which group *B* is composed of the 1st, 2nd and

4th genitals, while group A is made up of the 3rd and 5th. The following discrepancies have been noted as compared with the data stated by Lucas.

1. According to that author, the magnitude of the angle in group B should be equal or near to 90°, indicating a vertical position of the optic axis. In most of the investigated specimens, however, the axes considerably deviate from a vertical position. The angle at which they meet the surface of the plate is not lower than 50°.

Table 1

Inclination angles of the optic axis in the particular genitals and plates of the 5th interambulacrum

Species	Genital plates					IA 5
	1	2	3	4	5	
1. *Pygomalus analis*	81°	52°	<30°	60°	40°	83°
2. *Pygomalus ovalis*	69°	54°	39°	74°	34°	90°
3. *Pygorhytis ringens*	86°	68°	34°	71°	32°	85°
4. *Collyrites* sp.	75°	58°	35°	81°	<30°	83°
5. *Conulus* sp	78°	55°	35°	69°	—	—
6. *Pyrina* sp.	74°	51°	<30°	60°	—	—
7. *Psammechinus miliaris*	80°	62°	<30°	54°	<30°	—
8. *Echinocardium cordatum*	83°	64°	<30°	76°	40°	82°

2. In group A the optic axis is in several cases most certainly not parallel to the surface of the plate (as given by Lucas) and may meet it at an angle of even 40°. Nevertheless within certain limits (40°-<30°) this seems to be a constant magnitude.

3. Lucas state that the optic axes of ambulacral and interambulacral plates (by that author referred as radial and interradial, respectively) meet the test surface at a low angle. However, in the examined plates of the 5th interambulacrum the axial position is vertical or subvertical, while the deviation angle from that position never exceeds 10°. In addition to measurements made on universal rotating stage, numerous fragments of various parts of the test (including ambulacrals) of many echinoids have been examined in convergent light. Every examination revealed black cross placed centrally or subcentrally in the field of view, this being a characteristic representation of the vertical or subvertical position of the optic axis in the examined object.

The final definition of rules establishing the position of optic axes in the particular test plates of the examined echinoids would seem to be as follows.

1. In genitals of group B (1st, 2nd and 4th plates) the optic axes are

oriented so that the angle at which they meet the surface of plates always exceeds 50°.

2. In plates of group *A* (3rd and 5th genitals) the analogous angles are equal or lower than 40°.

3. In ambulacral and interambulacral plates the position of the optic axis is nearly vertical. Deviations range up to 10°.

The obtained data provide an affirmative replay to the question whether the plate observed at the base of the periproct in the Disasteridae may actually be recognized as the 5th genital. The angle of its optic axis is analogous to that of the 3rd genital, in which it distinctly differs from the adjacent plates of the interambulacrum.

Measurement data for *Disaster* n. sp. are lacking in the above discussed table. Crystallographic studies of the apical system of this form have shown that it does not belong either to type I or type II of apical system, where group *B* is composed of the 1st, 3rd and 4th genitals, and group *A* — of the 2nd and 5th. Representatives of type II have not been encountered by the present writer among the material in her possession.

The following numerical data have been obtained by examining the apical system and the periproctal area of *Disaster* n. sp. (tab. 2).

Table 2

Inclination angles of the optic axis in the particular genitals and plates of the 5th interambulacrum in four specimens of *Disaster* n. sp.

Specimens	Genital plates					IA 5
	1	2	3	4	5	
1. *Disaster* n. sp.	69°	50°	53°	<30°	<30°	83°
2. ,,	64°	45°	40°	<30°	—	85°
3. ,,	63°	43°	45°	<30°	<30°	87°
4. ,,	68°	44°	—	<30°	—	—

In the light shed by these results, from the standpoint of crystallographic analyses, *Disaster* n. sp. undoubtedly constitutes another type — III — in which group *B* is composed of the 1st, 2nd and 3rd genitals, while group *A* contains the 4th and 5th. Owing to inadequate material it has not been possible to ascertain whether this type of apical system is proper for this species only, or whether it is a generic feature. Moreover, it should be noted that the inclination angle limit (50°) in genitals of group *B,* proper for type I of the apical systems, has been exceeded in *Disaster* n. sp., where the respective magnitudes are somewhat below 50°. Investigation of more copious material is needed for the elucidation of this question.

Nevertheless, it should be stressed that in all the three so far ascertained types of apical systems, the 5th genital is always included in a group of plates showing strong axial inclination, and being thus easily identifiable. Doubtlessly this is an important feature in tracing the history of the 5th genital in irregular echinoids.

In view of the constant occurrence of certain inclination angles of the optic axes in the particular genitals, it might prove interesting to investigate from this standpoint the apical system in genera *Holectypus* and *Discoidea*. It is a known fact that though the periproct in these genera is already completely or partly on the oral side, nevertheless a complete set of 5 genitals is still present. Without going into a detailed discussion on the process of periproct migration in these forms, we should note that this is a problem as to whether the 5th genital here is the original genital plate, or whether possibly it is another element of the echinoid test, shifted into its place and, if perforated, taking over the function of the genital.

The following data have been obtained by examining the angles of the optic axes (tab. 3).

Table 3

Inclination angles of the optic axis in the particular genitals

Species	Genital plates				
	1	2	3	4	5
1. *Holectypus depressus*	60°	70°	<30°	59°	80°
2. *Discoidea subucula*	60°	52°	<30°	75°	72°

The above data indicate that the apical systems of these forms belong to type I (with strong axial inclination in the 3rd plate), but that the 5th plate conspicuously deviates from the angle proper for it (below 40°).

As the strong axial inclination in the 5th genital is an extremely constant feature, no modified even by the far reaching migration of that plate in the Disasteridae, it seems most likely that the 5th genital in above considered forms is not homologous with the original plate. We are dealing here with another element of the echinoid test which was shifted into its place and took over its function.

It should be noted that data obtained by the writer for *Discoidea subucula* do not agree with those given for that species by Lucas. According to that author, the optic axis of the 5th genital is here parallel to the surface. This should constitute a cardinal and very important difference. However, we may suppose that Lucas may have mistaken another form for *Discoidea subucula*. This supposition is suggested by his assignment of this species to the group of regular echinoids, which we know to be incorrect.

CONCLUSIONS

The constant position of optic axis in the particular skeletal elements of echinoids is a very interesting fact calling for more detailed analysis. The data given by Lucas, as well as those presented in this paper, are very fragmentary in view of small number of genera covered by measurements, and their fortuitous choice. Even in this meagre material not all the plates have been investigated (e.g. the oculars). Neither is it out of the question that when more copious material has been investigated, the here given magnitudes of angles of optic axes characterizing the various plate groups may prove inaccurate, thus modyfying the here differentiated subdivision.

Moreover, thus far, no sound interpretation has been advanced concerning the constant position of the optic axis in the various plate groups. It is not excluded that a solution of this problem might be possible in connection with studies on the early development stages of the skeleton. We know that some plates of the apical system develop jointly with the larval skeleton, while others as well as ambulacral and interambulacral plates are initiated as independent centres of calcification. One can presume that in the former group of plates the position of the optic axis is determined by the position of this axis in the remains of the larval skeleton with which the plates in question are associated. It should be mentioned too that the originally determined position of the optic axis does not change with growth stages (Becher, 1914).

The solution of the problem discussed calls for further investigations and the above considerations must be treated as merely tentative.

Palaeozoological Laboratory
of the Polish Academy of Sciences
Warszawa, May 1959

REFERENCES

BECHER, S. 1914. Über die Benutzung des Polarisationsmikroskops zur morphologischen Analyse des Echinodermenskelets. — *Zool. Jb., Abt. Anat. Ont. Tiere,* **38**, 211-252, Jena.

BEURLEN, K. 1934. Monographie der Echinoiden-Familie Collyritidae d'Orb. — *Palaeontographica,* **80**, A, 41-144, Stuttgart.

CUÉNOT, L. 1948. Anatomie, éthologie et systématique des Échinodermes. *In:* GRASSÉ, P. Traité de Zoologie, **11**, 3-275, Paris.

DEVRIÈS, A. 1954. A propos de la symétrie des Échinides. — *Publ. Serv. Carte géol. Algérie,* N. S., Bull. **1**, 2, 91-128, Alger.

DURHAM, W. & MELVILLE, R. V. 1957. A classification of Echinoids. — *J. Paleont.,* **31,** 1, 242-272, Menasha.

GORDON, I. 1926. The development of the calcareous test of Echinus miliaris. — *Phil. Trans. Roy. Soc. London,* Ser. B, **214**, 259-312. London.

GORDON, I. 1927. The development of the calcareous test of Echinocardium cordatum. — *Ibidem*, **215**, 255-313.

HAWKINS, H. L. 1934. The lantern and girdle of some recent and fossil Echinoidea. — *Ibidem*, **223**, 617-648.

— 1943. Evolution and habit among the Echinoidea: some facts and theories. — *Quart. J. Geol. Soc.*, **99**, 1/2, LII-LXXV, London.

LUCAS, G. 1953. Existence, dans l'appareil apical des Oursins, de deux sortes de plaques génitales. Plans de symétrie cristallographique. Hypothèses explicatives. — *C. R. Séances Acad. Sci.*, **237**, 5, 405-407, Paris.

MORTENSEN, Th. 1950. A monograph of the Echinoidea, V. 1: Spatangoida, 1-432. Copenhagen.

RÓŻYCKI, S. Z. 1953. Górny dogger i dolny malm Jury Krakowsko-Częstochowskiej. — *Prace Inst. Geol.*, 3-412, Warszawa.

UBISCH, L. v. 1913. Die Anlage und Ausbildung des Skeletsystems einiger Echiniden und die Symmetrieverhältnisse von Larve und Imago. — *Ztschr. Wiss. Zool.*, **104**, 119-156, Leipzig.

— 1927. Über die Symmetrieverhältnisse von Larve und Imago bei regulären und irregulären Seeigeln. — *Ibidem*, **129**, 541-566.

WEST, C. D. 1937. Note on the crystallography of the echinoderm skeleton. — *J. Paleont.*, **11**, 5, 458-459, Menasha.

WANDA JESIONEK-SZYMAŃSKA

PRZYCZYNEK DO ZNAJOMOŚCI TARCZY SZCZYTOWEJ JEŻOWCÓW NIEREGULARNYCH

Streszczenie

Dokładna analiza pancerzy jeżowców nieregularnych: *Pygomalus ovalis*, *P. analis*, *Pygorhytis ringens*, *Collyrites* sp. i *Disaster* n. sp. z batonu, keloweju i dolnego oksfordu Jury Krakowsko-Częstochowskiej pozwoliła stwierdzić obecność u podstawy peryproktu nie opisanej dotychczas płytki. U wszystkich wymienionych form płytka ta ma kształt półksiężycowaty, o mniej lub bardziej wydłużonych rogach; położona jest ona symetrycznie w stosunku do szwu, łączącego dwa rzędy płytek tylnego pasa interambulakralnego (fig. 1 i 2). U większości jest ona związana dość silnie z pancerzem, a tylko u *Pygomalus ovalis* słabiej, w związku z czym u tego gatunku rzadko się zachowuje (pl. I, fig. 1 i 2). Obecność tej płytki przy tylnym brzegu peryproktu nasuwała przypuszczenie, że jest to piąta płytka genitalna, zepchnięta do tego położenia przez przesuwający się peryprokt. Wniosek ten zyskuje poparcie w faktach obserwowanych na wczesnych stadiach rozwojowych *Echinocardium cordatum*. U jeżowca tego stwierdzono (Gordon, 1927), że migrujący peryprokt spycha stopniowo przed sobą piątą płytkę genitalną, która ostatecznie staje się jedną z płytek peryproktalnych (fig. 3 *B*, *C*).

Uznanie płytki znalezionej u wspomnianych na początku form za piątą genitalną zyskało także poparcie na drodze badań krystalograficznych, w których wyzy-

skano ostatnio skonstatowany fakt (Lucas, 1953), że oś optyczna poszczególnych płytek genitalnych ma stały kąt nachylenia w stosunku do ich powierzchni. Płytka piąta odznacza się bardzo silnym pochyleniem osi optycznej (kąt, z reguły, poniżej 40°) i jest łatwa do odróżnienia w świetle spolaryzowanym od płytek ambulakralnych i interambulakralnych, u których oś optyczna jest prawie prostopadła do powierzchni (pl. I, fig. 3). Szlify cienkie okolicy peryproktalnej wymienionych form, zbadane tą metodą na stoliku Fedorowa, wykazały obecność w nich piątej płytki genitalnej (tab. 1 i 2). Podobne badania tarcz szczytowych *Holectypus depressus* i *Discoidea subucula* (tab. 3) wykazują, że obecna u nich piąta płytka genitalna nie jest pierwotną, lecz stanowi jakiś inny element pancerza, który wszedł na jej miejsce i przejął jej funkcję (przypuszczenie takie było już w literaturze echinologicznej wypowiadane).

OBJAŚNIENIA DO ILUSTRACJI

Fig. 1 (p. 341)

A *Pygomalus analis*, B *Pygorhytis ringens*, C *Collyrites* sp.; *am* pas ambulakralny, *ia* pas interambulakralny, *g* płytka półksiężycowata, *o* płytka ocelarna, *pp* peryprokt.

Fig. 2 (p. 342)

Disaster n. sp., fragment pancerza: *a* widziany z zewnątrz, *b* od wewnątrz, *g* płytka półksiężycowata, *ia* pas interambulakralny.

Fig. 3 (p. 343)

A tarcza szczytowa *Acrosalenia angularis* (Cuénot, 1948); *B* młode stadium *Echinocardium cordatum* (Gordon, 1927), *C* peryprokt *Echinocardium cordatum* (Gordon, 1927); g_5 piąta płytka genitalna, *pp* peryprokt. Wszystkie figury przerysowane i nieco zmodyfikowane.

Pl. I

Fig. 1. Okolica peryproktalna *Pygomalus ovalis* z wyraźną półksiężycowatą płytką u podstawy peryproktu.

Fig. 2. Okolica peryproktalna *Pygomalus ovalis* bez płytki, lecz z widocznym wcięciem po jej wypadnięciu.

Fig. 3. Szlif okolicy peryproktalnej *Disaster* n. sp. oglądany przy nikolach skrzyżowanych. Płytka półksiężycowata wyraźnie jaśniejsza, niż otaczające ją od dołu płytki interambulakralne.

ВАНДА ЕСЁНЭК-ШИМАНЬСКА

К ИЗУЧЕНИЮ АПИКАЛЬНОГО ПОЛЯ НЕПРАВИЛЬНЫХ МОРСКИХ ЕЖЕЙ

Резюме

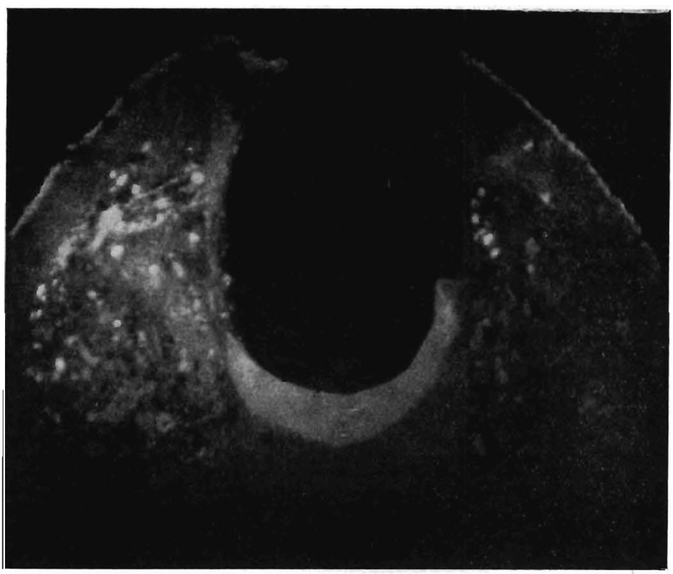
Обстоятельный анализ панцырей неправильных морских ежей: *Pygomalus ovalis*, *P. analis*, *Pygorhytis ringens*, *Collyrites* sp. и *Disaster* n. sp. из бата, келловея и нижнего оксфорда Краковско-Ченстоховской юры дал возможность установить присутствие у основания перипрокта не описанной до сего времени пластинки. У всех приведенных морских ежей пластинка эта имеет форму полумесяца с более или менее удлиненными рогами и расположена симметрично относительно шва, соединяющего два ряда пластинок заднего интерамбулакра (фиг. 1 и 2). У большинства форм она связана довольно прочно с панцырем и только у *Pygomalus ovalis* соединение более слабое, в связи с чем рассматриваемая пластинка очень редко сохраняется у этого вида (пл. I, фиг. 1, 2). Наличие этой пластинки у заднего края перипрокта заставляет предполагать, что она является пятой генитальной пластинкой сдвинутой в это положение перемещающимся перипроктом.

Заключение это находит подкрепление в фактах наблюдаемых на ранних стадиях развития *Echinocardium cordatum*. У этого морского ежа установлено (Gordon, 1927), что мигрурующий перипрокт сдвигает постепенно перед собой пятую генитальную пластинку, которая в конце концов становится одной из перипроктальных пластинок (фиг. 3 *B*, *C*).

В пользу толкования пластинки у упомянутых в начале форм, как пятой генитальной, говорят тоже результаты кристаллографических исследований, при которых использовано установленный в последнее время факт (Lucas, 1953), что оптическая ось отдельных генитальных пластинок имеет постоянный угол наклона относительно их поверхности. Пятая пластинка отличается очень большим наклоном оптической оси (как правило — угол ниже 40°) и легко отличима в поляризованном свете от амбулакральных и интерамбулакральных пластинок, у которых оптическая ось почти перпендикулярна к поверхности (пл. I, фиг. 3). Тонкие шлифы перипроктальной области указанных выше форм, исследованные этим методом на федоровском столике, обнаружили наличие в них пятой генитальной пластинки (таб. 1 и 2). Результаты подобного рода исследований над апикальным полем *Holectypus depressus* и *Discoidea subucula* (таб. 3) указывают на то, что имеющаяся у них пятая генитальная пластинка не является первичной, но каким то другим элементом панцыря, который занял ее место и перенял ее функцию. (Такое предположение уже высказывалось в ехинологической литературе).

1

2



3

Fig. 1. *Pygomalus ovalis*, periproctal area showing the distinct crescentic plate at the base of the periproct.

Fig. 2. *Pygomalus ovalis*, periproctal area without the crescentic plate showing the incision left by the fallen out plate.

Fig. 3. *Disaster* n. sp., thin section in periproctal area under crossed nicols. Crescentic plate distinctly lighter than the interambulacral plates surrounding it at the base.