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Teratology in chitons (Mollusca, Polyplacophora): a brief summary

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Abstract
The present paper provides an overview of the present stage of knowledge of chiton abnormalities, which are divided into four cases: hypomerism, hypermerism, coalescence and splitting. Representatives for each group are illustrated and in addition two new records for five and nine valved chitons are reported: the first record of a hypomerized specimen of *Tonicia elegans* (Frembly, 1827), and the first occurrence of a hypermerized specimen of *Tonicella zotini* Jakovleva, 1952. With the new data, the number of five valved species increased to eight, while 10 species are now known with nine plates. In addition, the present paper summarizes the data available for chiton defects and other abnormalities, which do not fit the above mentioned categories.

Riassunto
Viene presentato un riepilogo dell'attuale livello di conoscenza sulle anomalie dei poliplacofori (chitoni), suddivise in quattro gruppi: ipomeria, ipermeria, coalescenza e suddivisione. L'ipomeria si identifica con la completa assenza di una o più piastre rispetto alle otto normali, l'ipermeria con l'aggiunta di un'ulteriore piastra, la coalescenza con l'atrofia di una parte di una piastra e l'unione della piastra con quella adiacente ed infine la suddivisione di una piastra in due metà, di cui una indipendente e l'altra che presenta coalescenza con la piastra precedente. Sono illustrati alcuni esempi significativi per ciascun gruppo, ed anche due nuove segnalazioni relative ad ipomeria [un esemplare di *Tonicia elegans* (Frembly, 1827) dal Cile con cinque piastre] ed ipermeria (un esemplare di *Tonicella zotini* Jakovleva, 1952 dalla baia di Vostok con nove piastre). Con questi nuovi dati, si porta ad otto il numero di specie conosciute con cinque piastre, mentre diventa 10 quello relativo a specie con nove piastre. In aggiunta, vengono analizzati i dati disponibili relativi ad altre anomalie o difetti segnalati per i poliplacofori, che non rientrano nei gruppi precedentemente indicati.

Key words
Polyplacophora, teratology, hypomerism, hypermerism, coalescence, splitting.

Introduction

Polyplacophora show dorsally eight usually overlapping calcareous plates, but the number of plates was considered to vary by old authors, and it was therefore necessary to specify this number when describing each species. Linnaeus (1758) described four species in his newly introduced genus *Chiton*: *C. hispidus* with six plates ("*C. testa sexvalvi striata*"), *C. tuberculatus* with seven plates ("*C. testa septemvalvi, corpore tuberculato*"), and two other species with eight plates, *C. aculeatus* ("*C. testa octovalvi striata*") and *C. punctatus* ("*C. testa octovalvi laevi*") (Dodge, 1952), indicating that he regarded the normal number of valves as varying from six to eight.
Other authors who described species with a number of plates different from the usually eight, emanate from the same variability, *i.e.* *Chiton squamosus denticularis testa septem-valvi-striata* Chemnitz, 1788, *Chiton septemvalvis* Montagu, 1803, *Chiton quinquevalvis* Brown, 1827.
Some illustrations of chitons with an untypical number of plates appeared in papers of the 18th century, but in some cases the anomalies could be due to errors in drawing. This especially can be true for the oldest available illustration in Scheuchzer (1733: vol. 3, pl. 554), where a specimen with nine plates is displayed (**Fig. 1**).
The possibility of an error due to the drawings may be confirmed by the lacking of information on species with nine plates at that time. The illustrations by Bruguière in Bruguière et al. (1792: pl. 162, fig. 10; pl. 163, figs 4-5) in which two species with seven plates and one with six plates are presented, seem to be more reliable.
Another example is given by the drawings in Tapparone-Canefri (1874), referring to *Acanthochitona defilippii* (Tapparone-Canefri, 1874). This specimen shows seven plates and in this case too, since there is no description of the species, the peculiarity could also be due to a drawing error.
Several authors discussed the phenomenon of the variation in the number of valves, i.e. O.G. Costa (1841), Pilsbry (1892: "*It is likely that the six-valved were artificial fabrications, although a certain number may perhaps be traced to incorrect drawings. Most seven-valved specimens are due to soldering together of two valves in consequence of some injury. This is not uncommon, a number of cases having come under my observation. Individuals actually seven-valved are known to occur, although they are far from common. The writer has examined many thousand Chitons, but has only seen two normally 7-valved examples. One of this … is in no respect abnormal save in the want of one central valve, and the consequent lengthening of the others. There is absolutely*

Fig. 1. The oldest available illustration of a species with nine plates, but probably an incorrect drawing (from Scheuchzer, 1733: pl. 554, fig. "B", modified to enlarge the view of the nine plates chiton).

Fig. 1. La più vecchia illustrazione disponibile di una specie con 9 piastre, probabilmente un disegno errato (da Scheuchzer, 1733: tav. 554, fig. "B", modificato per ingrandire la vista del chitone con 9 piastre).

no trace of the missing valve. The absence of a valve produces no striking change in the general appearance of the animal."), Iredale & Hull (1926), and Iw. Taki (1932).

Abbreviations

BD Bruno Dell'Angelo study collection;
ZISP Zoological Institute of Russian Academy of Sciences, St. Petersburg, Russia;
ZSM Zoologische Staatssammlung Muenchen, Munich, Germany.

Classification of abnormality of shell-plates

A general review of the anomalies in chitons was carried out by Pelseneer (1919, 1920, 1923), Hoffmann (1930) and Iw. Taki (1932). We differentiate the following four cases: hypomerism, hypermerism, coalescence, and splitting.

Hypomerism (Figs 2A-C)

Hypomerism is the complete absence of a certain number of shell-plates. The reduction may affect various number of plates; in fact, specimens with three to seven plates are known, but a four-valved specimen has not been recorded yet. The specimens appear to be normal in their general appearance, therefore, it is possible that this type of anomaly is caused by a complete atrophy of one or more vestiges of plates in the developing stage.

Only one specimen of Polyplacophora with three plates is known: *Ischnochiton contractus* (Reeve, 1847), collected in Victoria, Australia (Sykes, 1900: fig. 1) and deposited in the British Museum of Natural History. In this specimen the tail valve occupies a space larger rather than equal to that taken by the head and median valves together. Due to the incorrect interpretation of a citation by Henn (1894) ("*Cryptoplax striatus Lam. One specimen, three valves*"), several authors have mistakenly reported a second case with three plates. Actually, Henn's species report refers to a normal specimen and three additional isolated valves.

Polyplacophora with five plates are also rare. Dell'Angelo & Tursi (1990) reported only seven specimens belonging to seven different species. An additional species, namely *Tonicia elegans* (Frembly, 1827) from Chile, is here illustrated (**Fig. 2A**).

A considerable large number of specimens with six plates were mentioned by Dell'Angelo & Tursi (1990): 40 specimens belonging to 23 species. One of these, *Chiton corallinus* (Risso, 1826) is here illustrated (**Fig. 2B**).

The most common specimens are those with seven plates. Dell'Angelo & Tursi (1990) reported 269 specimens belonging to 86 species, again, *Chiton corallinus* (Risso, 1826), is here as representative illustrated (**Fig. 2C**).

Hypermerism (Figs 1, 2D-E)

Hypermerism is the presence of more than eight plates. To date, only 13 specimens belonging to nine species have been reported in this category and all specimens have nine valves (Dell'Angelo & Cianfanelli, 2002). One of these, *Acanthopleura gemmata* (de Blainville, 1825) is here illustrated (**Fig. 2D**). In the collection of ZISP, the second author was able to study a nine valved specimen of *Tonicella zotini* Jakovleva, 1952 from the Vostok Bay, a species not reported before with some anormalities (**Fig. 2E**). Four specimens of Mediterranean *Acanthochitona* species are known (Dell'Angelo, 1985, Dell'Angelo et al., 1998): three of *A. fascicularis* (Linnaeus, 1767) and one of *A. crinita* (Pennant, 1777). All of them have an extra pair of tufts on the girdle (20 instead of 18), whereas in cases of hypomerism can be a deficiency in pairs of tufts and in cases of coalescence can be a minor number of single tufts. Taki (1932) reports a specimen of *Acanthochitona rubrolineata* (Lischke, 1873) with seven plates and one pairs of tufts fewer (Taki, 1932: fig. 1), and this fact suggests that the tufts on the girdle have a close relationship with the formation of the plates.

Coalescence (Fig. 3)

Coalescence is the atrophy of a certain area of a shell-

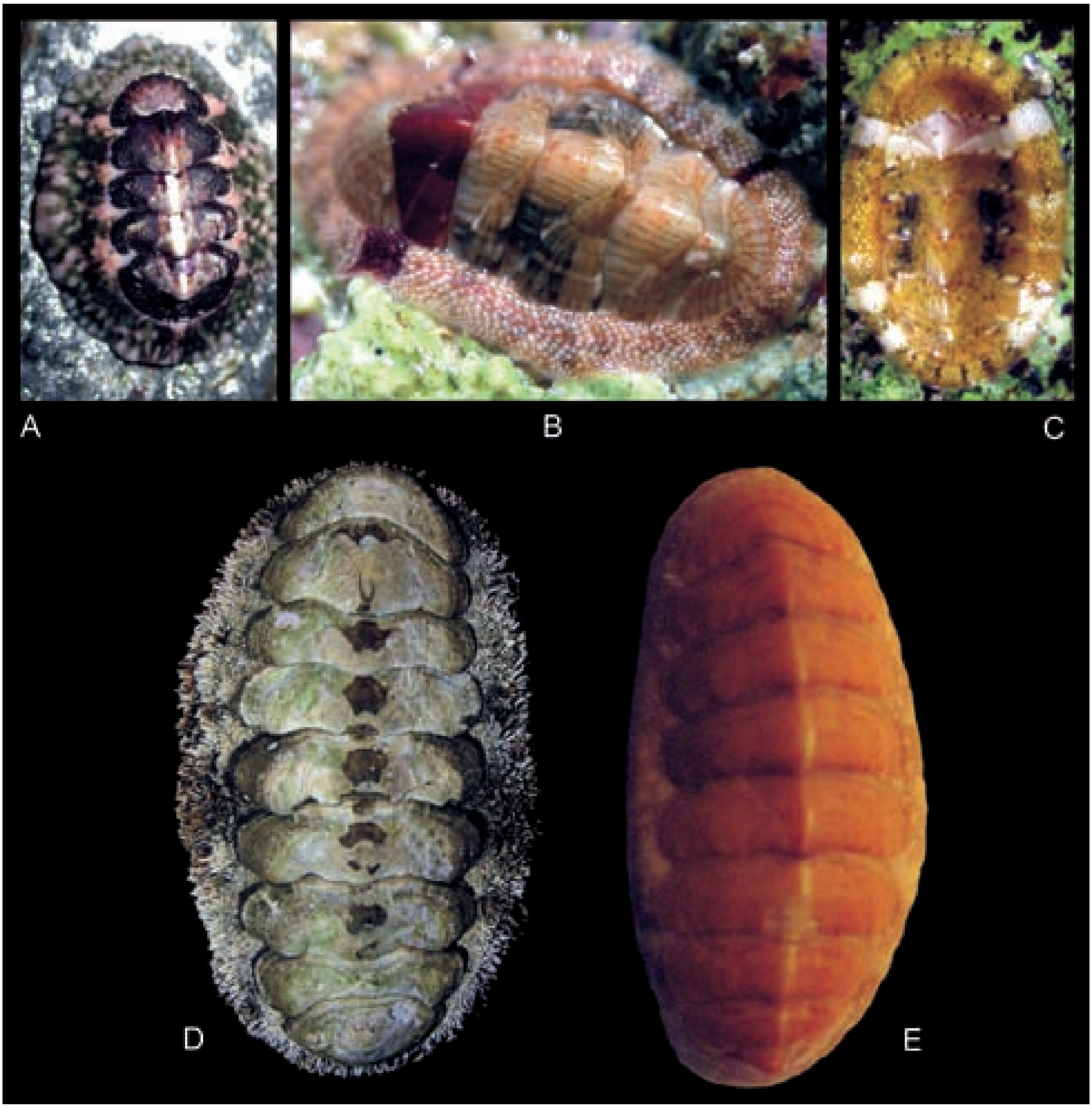

Fig. 2. A. *Tonicia elegans* (Frembly, 1827) from Chile, La Mission (near Valdivia), with 5 plates (ZISP) (photo and collected by Boris Sirenko). **B.** *Chiton corallinus* (Risso, 1826) from Rovinj, Croatia, with 6 plates (ZSM Mol 20071145). **C.** *Chiton corallinus* (Risso, 1826) from Rovinj, Croatia, with 7 plates. **D.** *Acanthopleura gemmata* (de Blainville, 1825) from Mogadischu, Somalia, with 9 plates (Cianfanelli collection). **E.** *Tonicella zotini* Jakovleva, 1952 from Vostok Bay, Russia, collected by Boris Sirenko, with 9 plates (ZISP).

Fig. 2. A. *Tonicia elegans* (Frembly, 1827) dal Cile, La Mission (vicino a Valdivia), con 5 piastre (ZISP) (foto e raccolta di Boris Sirenko). **B.** *Chiton corallinus* (Risso, 1826) da Rovigno, Croazia, con 6 piastre (ZSM Mol 20071145). **C.** *Chiton corallinus* (Risso, 1826) da Rovigno, Croazia, con 7 piastre. **D.** *Acanthopleura gemmata* (de Blainville, 1825) da Mogadiscio, Somalia, con 9 piastre (collezione Cianfanelli). **E.** *Tonicella zotini* Jakovleva, 1952 da Vostok Bay, Russia, raccolto da Boris Sirenko, con 9 piastre (ZISP).

plate, and coalescence of that plate with the adjacent plate. There are various degrees of plate reductions and of coalescence. An extreme case in *Boreochiton granulatus* (Jakovleva, 1952) was described and illustrated by Dell'Angelo (1982): the specimen shows a coalescence of the first three plates into one plate i-ii-iii (**Fig. 3**). Taki (1932) reported various cases of coalescence in Japanese species, and observed that coalescence is more complete in the *tegmentum* than in the *articulamentum*, suggesting that the fusion apparently advances from dorsal to ventral direction. The only case of coalescence in fossils was reported by Dell'Angelo & Forli (1995b), based on two valves of the Pliocene *Chiton saeniensis* Laghi, 1984 from Serre di Rapolano (Siena).

Splitting (Fig. 4)

Splitting is the division of one plate into two halves of which one is independent, whereas the other presents coalescence with the adjacent plate. In this case, no decrease in the number of plates occurs, as exemplarily reported by Taki (1932) for *Liolophura japonica* (Lischke, 1873) (**Fig. 4**). The monstrosity of this specimen is caused by the longitudinal splitting of valve v, which

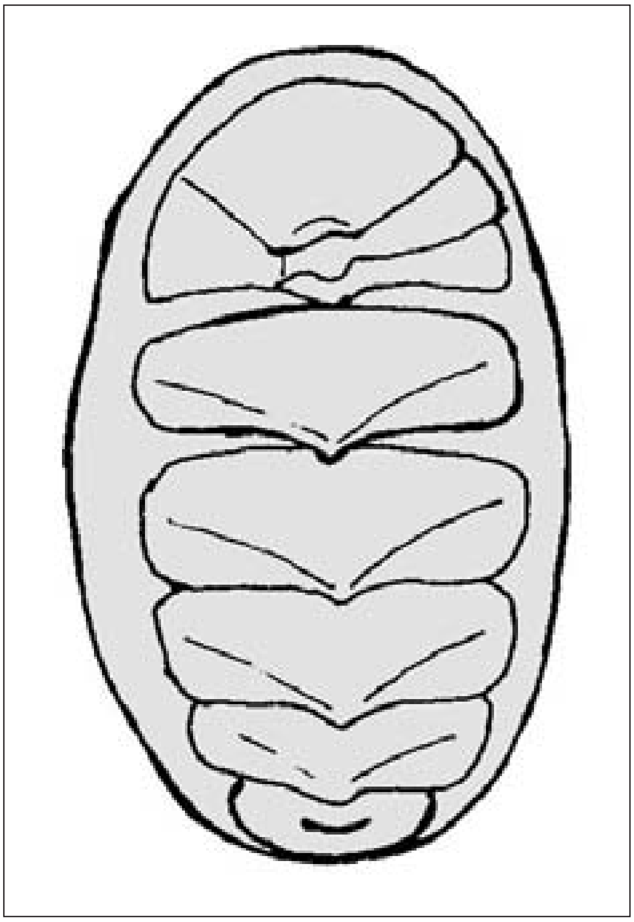

Fig. 3. *Boreochiton granulatus* (Jakovleva, 1952), from Sakhalin Id., Japan Sea that shows a coalescence of the first three plates into one plate i-ii-iii (after a drawing by B. Sirenko).

Fig. 3. *Boreochiton granulatus* (Jakovleva, 1952), dall'isola di Sakhalin, Mar del Giappone che mostra coalescenza delle prime tre piastre in una piastra i-ii-iii (da un disegno di B. Sirenko).

may have taken place in an earlier stage of development by the coalescence of the valve's left half with the preceding valve, while the right half being left independent. Hence, the reduction of the shell-plate is scarcely noticed in this specimen, which has a normal length of body instead of being axially shortened.

Other abnormalities

The following other cases of abnormalities have been reported in literature.

a. The loss of one side of a median valve, and the complete closure of the resulting gap, with a consequent shortening of the injured side and curvature of the dorsum [see Iredale & Hull, 1926: pl. 17, fig. 18, showing a specimen of *Rhyssoplax jugosus* (Gould, 1846)]. A similar case (for "*Callochiton platessa*") was described by Oliver (1921). He mentioned an asymmetry in a specimen as a result of the fusion of two intermediate valves. In this case one valve half overlaid the other so much that a second apex is visible.

b. The dorsal fracture of one or more valves, with a curious recurved prolongation of the fractured edges resulting from a determined effort on the part of the animal to repair the damage (see Iredale & Hull, 1926: pl. 17, fig. 17, showing a specimen of *Liolophura queenslandica* Pilsbry [= *L. gaimardi* (de Blainville, 1825)]). The fracture of valves is probably not uncommon in chitons. Tucker & Giese (1959) studied the plates of 146 specimens of *Cryptochiton stelleri* (von Middendorff, 1847), and found the fracture of one or more plates and the ability to auto-solder by the animal in 59.5% of the cases.

c. The presence of a conical process on the girdle of a

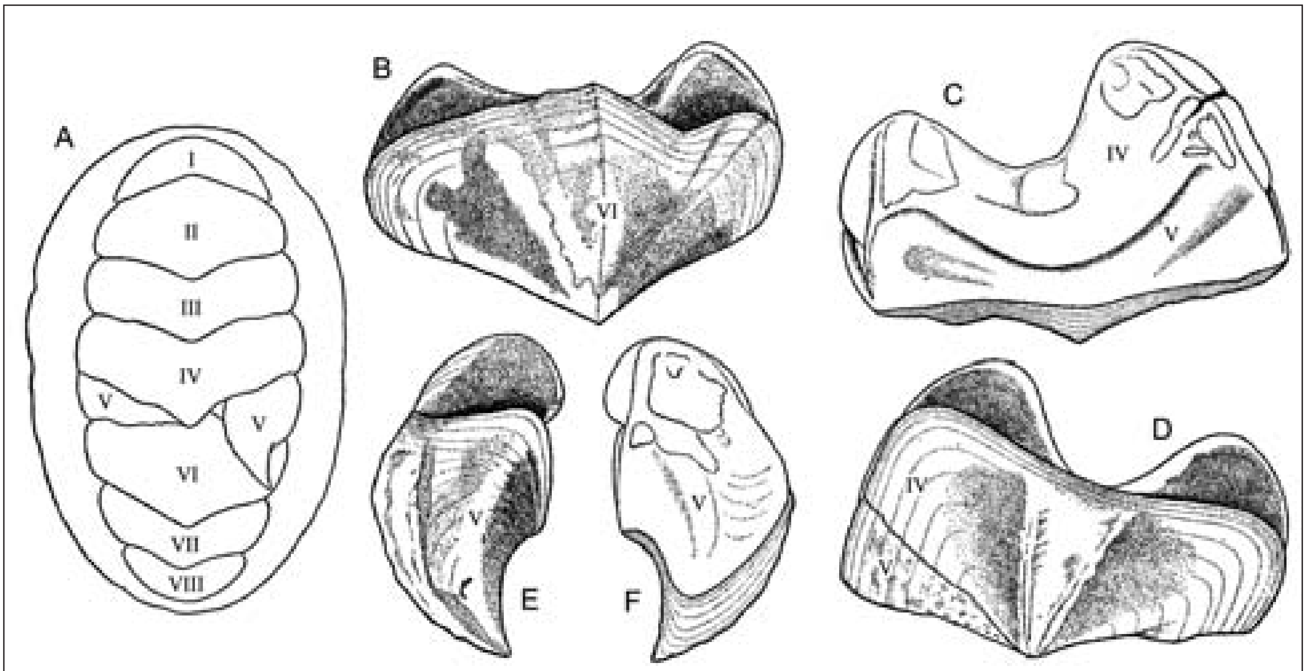

Fig. 4. *Liolophura japonica* (Lischke, 1873) from Gogoshima, Japan, showing a splitting of valve v. **A.** Dorsal view of the whole specimen. **B**. Dorsal view of valve vi. **C, D.** Dorsal and ventral views of valves iv-v. **E, F.** Dorsal and ventral views of the right half of valve v (after Taki, 1932 modified).

Fig. 4. *Liolophura japonica* (Lischke, 1873) da Gogoshima, Giappone, che mostra la suddivisione della piastra v. **A.** Vista dorsale dell'esemplare intero. **B**. Vista dorsale della piastra vi. **C, D.** Viste dorsale e ventrale delle piastre iv-v. **E, F.** Viste dorsale e ventrale della metà destra della piastra v. (da Taki, 1932 modificato).

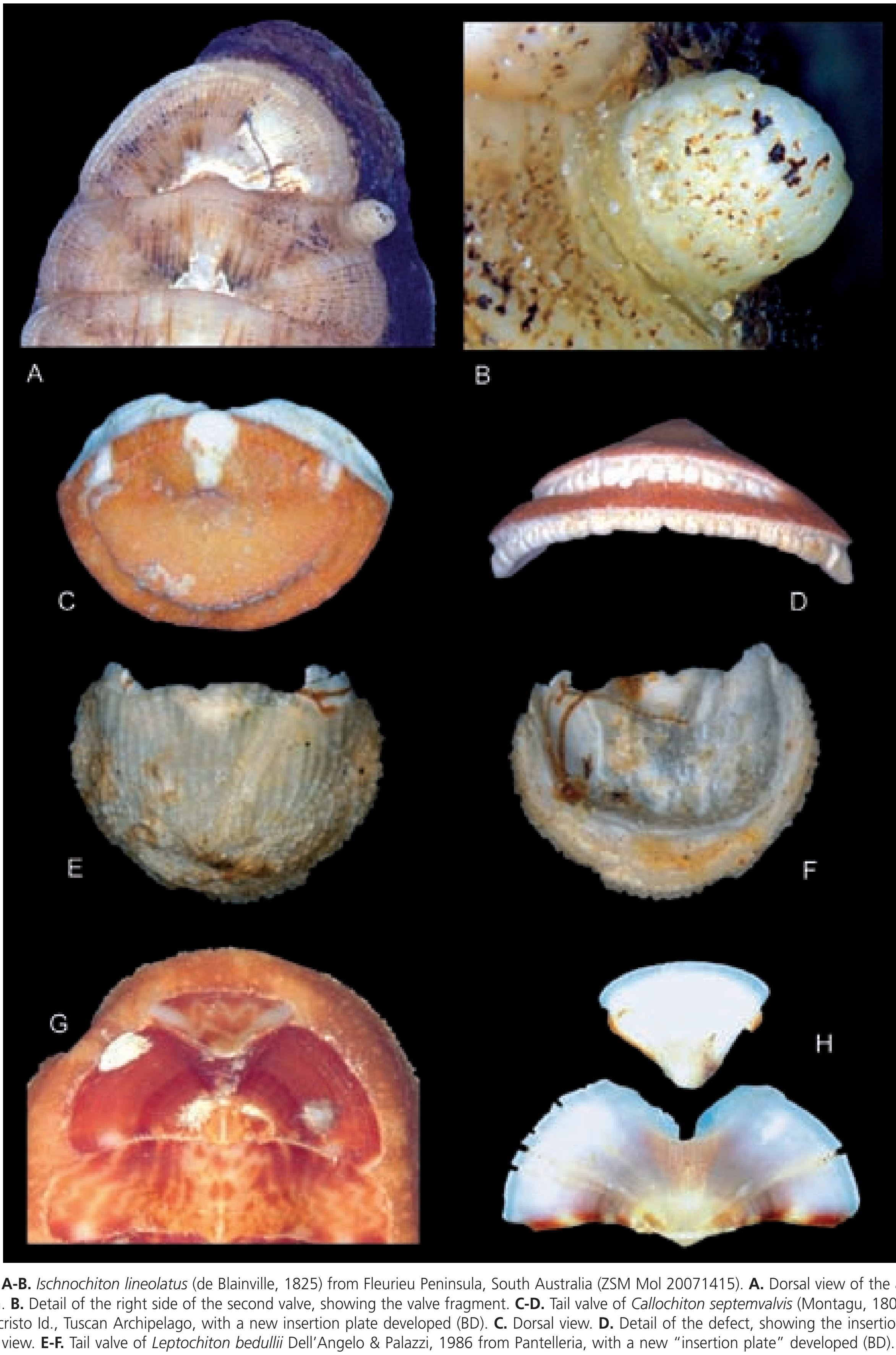

Fig. 5. A-B. *Ischnochiton lineolatus* (de Blainville, 1825) from Fleurieu Peninsula, South Australia (ZSM Mol 20071415). **A.** Dorsal view of the anterior portion. **B.** Detail of the right side of the second valve, showing the valve fragment. **C-D.** Tail valve of *Callochiton septemvalvis* (Montagu, 1803) from Montecristo Id., Tuscan Archipelago, with a new insertion plate developed (BD). **C.** Dorsal view. **D.** Detail of the defect, showing the insertion plate, frontal view. **E-F.** Tail valve of *Leptochiton bedullii* Dell'Angelo & Palazzi, 1986 from Pantelleria, with a new "insertion plate" developed (BD). **E.** Dorsal view. **F.** Detail of the defect, showing the insertion plate, ventral view. **G-H.** *Boreochiton ruber* (Linnaeus, 1767) from Haganes, Norway (ZSM Mol 20034301). **G.** Detail of the anterior portion, showing the deformed head valve. **H.** ventral view of the first two valves.

Fig. 5. A-B. *Ischnochiton lineolatus* (de Blainville, 1825) dalla Penisola di Fleurieu, S. Australia (ZSM Mol 20071415). **A.** Vista dorsale della parte anteriore. **B.** Dettaglio del lato destro della seconda piastra, che mostra il frammento della piastra. **C-D.** Piastra posteriore di *Callochiton septemvalvis* (Montagu, 1803) dall'isola di Montecristo, Arcipelago toscano, con una nuova piastra di inserzione sviluppata (BD). **C.** Vista dorsale. **D.** Dettaglio dell'anomalia che mostra la nuova piastra di inserzione, vista frontale. **E-F.** Piastra posteriore di *Leptochiton bedullii* Dell'Angelo & Palazzi, 1986 dall'isola di Pantelleria, con una nuova piastra di inserzione sviluppata (BD). **E.** Vista dorsale. **F.** Dettaglio dell'anomalia che mostra la nuova piastra di inserzione, vista ventrale. **G-H.** *Boreochiton ruber* (Linnaeus, 1767) da Haganes, Norvegia (ZSM Mol 20034301). **G.** Dettaglio della parte anteriore, che mostra la piastra anteriore deformata. **H.** Vista ventrale delle prime due piastre.

specimen of *Chaetopleura angulata* (Spengler, 1797), reported by Van Belle (1983: figs 1, 2), and interpreted as the isolated development in height of a small part of the plate ii margin, separated from the plate in consequence of an old fracture in plates ii and iii. A similar case was reported by Schwabe (2009) for a specimen of *Ischnochiton lineolatus* (de Blainville, 1825) and is illustrated here (**Figs 5A-B**).

d. The presence of a defect in terminal plates, that can present an injury and develop a new insertion plate under the already existing one. This abnormality was reported by Dell'Angelo & Palazzi (1983b) for a tail valve of *Callochiton septemvalvis*, Baschieri et al. (1992) for the head valve of *Callochiton septemvalvis*, Dell'Angelo & Forli (1995a) for the head valve of the Pleistocene *Chiton etruscus* Dell'Angelo & Forli, 1995, and Schwabe (2001) for the head valve of *Chiton cumingsii* Frembly, 1827 and a tail valve of *Ischnochiton tridentatus* Pilsbry, 1893. Here two cases are illustrated that show this abnormality in the tail valve (**Figs 5C-F**). Remarkable, in none of the previously mentioned cases the development of the insertion plate from the ventral side was ever documented.

e. Schwabe (2009) reported a case that neither may attributed to splitting nor to coalescence in the strict sense of their definitions. He illustrated a specimen of *Boreochiton ruber* (Linnaeus, 1767) with a plectron-like head valve without incisions. The "second" valve shows the characters of both, the head valve and the second valve. The general outline and the multiple slits of one valve half strongly resemble the conditions of a normal grown head valve. The single slit and the presence of apophyses however are typical characters of a normal grown second valve (**Figs 5G-H**).

Summary of the cases of abnormalities reported in literature

The most complete list of the anomalous cases is provided by Dell'Angelo & Tursi (1990), who summarized 325 cases of abnormalities, belonging to 100 species.

The reports of anomalous chitons are quite rare, most papers indicate very few specimens. Iredale & Hull (1926) reported 102 Australian specimens belonging to 36 species (but see Robertson, 1973), Roth (1966) listed 12 specimens from Washington State belonging to nine species, Burghardt & Burghardt (1969) documented 24 specimens from California and British Columbia, belonging to 12 species. Dell'Angelo (1982, 1985), Dell'Angelo & Palazzi (1983a, 1983b), Dell'Angelo & Tursi (1990), Dell'Angelo & Cianfanelli (2002), and Dell'Angelo et al. (1998) reported 36 specimens (including 31 from the Mediterranean Sea) belonging to ten species. Baschieri et al. (1992) report 20 specimens from the Mediterranean Sea belonging to seven species.

It is generally supposed that the malformed chiton specimens are of rather rare occurrence, and at present is very difficult to estimate the percentage of anomalous specimens. The only data available are from Pilsbry (1892) who mentioned only two 7-valved specimens among many thousand chitons analyzed, Crozier (1919) detected only two coalesced specimens of 2,100 chitons, Iredale & Hull (1926) estimated two abnormal specimens per 1000 specimens of 30,000-40,000 Australian chitons they analyzed, Langer (1978a) investigated 5622 specimens and came to an estimated rate of five abnormalities per 1000 specimens, and Dell'Angelo & Forli (1995b) only found two coalesced fossil valves among over 1,000 valves they examined.

Correlation between plate anomalies and morphological or ecological aspects

At present, the data available for possible correlation between plate anomalies and morphological or ecological aspects is too scarce. Examinations by Kniprath (1980) and Sirenko & Kashenko (1990) have shown, that chiton larvae sensitively may react on temperature and salinity changes. Divergences from the optimum of this parameters lead to a protracted metamorphosis, including an interrupted shell development.

Taki (1932) studied some correlations with morphological characters, in particular the length of the animal (p. 54: "*If the shell-plate has undergone hypomerism, the body is usually shortened at the same time… It seems significant that the body length as well as the outline of the whole body, is closely correlated with the number of existing shell-plates.*") and the number of ctenidia (p. 56: "*I am inclined to believe that the ctenidium may develop normally without any connection with the hypomerism of the shell-plate.*").

As already pointed out, there is a correlation between the number of tufts on the girdle (in *Acanthochitona* species) and the number of shell-plates (hypomerism-hypermerism).

A possible correlation with ecological factors was studied by Langer (1978b: "*The benthic distribution of variants and their greater frequency at the environmentally less severe Deep Cove site suggest that occurrence of variants is not directly influenced by surf-related factors, temperature, or salinity extremes. The frequency of variation did correlate with population density.*"). According to the data reported by Langer (1978a) it seems that, at least in the cases he examined, a correlation between the variation frequency and the depth can be excluded.

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References

Baschieri L., Dell'Angelo B. & Palazzi S., 1992. Recenti ritrovamenti di Polyplacophora anomali nel Mediterraneo. *Bollettino Malacologico*, **28**: 65-68.

Bruguière J.G., Lamarck J.B. & Bory de Saint Vincent, 1791/1827. *Tableau encyclopedique et methodique des trois reg-*

nes de la nature. Vers, coquilles, mollusques et polypiers. Paris, 3 vols.: i-viii, 1-180, 1-16, pls 1-488.

Burghardt G. & Burghardt L., 1969. Report on some abnormal Chitons from California and British Columbia. *The Veliger*, **12**: 228-229.

Costa O.G., 1841. Fauna del Regno di Napoli ossia enumerazione di tutti gli animali che abitano le diverse regioni di questo regno e le acque che le bagnano… Gasteropodi. Napoli, foglio 26: 1-8, pl. 3.

Crozier W.J., 1919. Coalescence of the shell plates in Chiton. *American Naturalist*, **53**: 278-279.

Dell'Angelo B., 1982. Sui casi di anomalie nel numero di piastre dei Polyplacophora. *Bollettino Malacologico*, **18**: 235-246.

Dell'Angelo B., 1985. Ipermeria in *Acanthochitona* (Mollusca: Polyplacophora) delle coste livornesi. *Quaderni del Museo di Storia Naturale di Livorno*, **5** (1984): 77-80.

Dell'Angelo B. & Cianfanelli S., 2002. Una nuova segnalazione di ipermeria nei molluschi poliplacofori. *Atti della Società toscana di Scienze Naturali, Memorie B*, **108**: 27-28.

Dell'Angelo B. & Forli M., 1995a. I Polyplacophora del Pleistocene inferiore di Riparbella (Pisa), con elenco dei molluschi rinvenuti. *Bollettino Malacologico*, **30** (1994): 221-252.

Dell'Angelo B. & Forli M., 1995b. Ritrovamento di piastre anomale di *Chiton saeniensis* Laghi, 1984 (Mollusca: Polyplacophora). *Bollettino Malacologico*, **31**: 77-80.

Dell'Angelo B., Lombardi C. & Ventimiglia S., 1998. Due nuove segnalazioni di ipermeria in Poliplacofori. *La Conchiglia*, **30** (287): 15-16.

Dell'Angelo B. & Palazzi S., 1983a. Recenti ritrovamenti di Polyplacophora anomali in Sardegna. *Bollettino Malacologico*, **19**: 253-256.

Dell'Angelo B. & Palazzi S., 1983b. Una interessante anomalia strutturale in *Callochiton achatinus* (Brown, 1823) (Mollusca, Polyplacophora). *Quaderni del Museo di Storia Naturale di Livorno*, **4**: 75-76.

Dell'Angelo B. & Tursi A., 1990. Abnormalities in chitons shell-plates. *Oebalia*, **14** N.S. (1987-88): 1-14.

Dodge H., 1952. A Historical Review of the mollusks of Linnaeus. Part 1. The Classes Loricata and Pelecypoda. *Bulletin of the American Museum of Natural History*, **100**: 1-264.

Henn A.U., 1894. List of Mollusca found at Green Point, Watson's Bay, Sydney. *Proceedings of the Linnean Society of New South Wales*, **9**: 165-182, 1 pl.

Hoffmann H., 1930. *Schalenbrüche und Anomalien*. *In*: Bronn H.G. (ed.), *Klassen und Ordnung der Tierreichs*. **3** (1): 173-174.

Iredale T. & Hull A.F.B., 1926. A Monograph of the Australian Loricates (Phylum Mollusca - Order Loricata). Appendix A. Teratology. *Australian Zoologist*, **4**: 272-275.

Kniprath E., 1980. Ontogenetic plate and plate field development in two chitons, *Middendorffia* and *Ischnochiton*. *Wilhelm Roux's Archives of Developmental Biology*, **189**: 97-106.

Langer P.D., 1978a. *Some aspects of the biology of three northwestern Atlantic chitons: Tonicella rubra, Tonicella marmorea and Ischnochiton albus (Mollusca: Polyplacophora)*. University of New Hampshire, Thesis: i-xii, 1-170.

Langer P.D., 1978b. Abnormality of Shell Plates in three chitons from New England. *The Veliger*, **21**: 274-275, 1 pl.

Linnaeus C., 1758. *Systema Naturae. Editio decima, reformata.* Tomus I. Holmiae, L. Salvii: 1-667.

Oliver W.R.B., 1921. Variation in Amphineura. *Transactions and Proceedings of the New Zealand Institute*, **53**: 361.

Pelseneer P., 1919. La métamérie et l'hypomérie chez les Chitons. *Annales de la Société Royale Zoologique et Malacologique de Belgique*, **50**: 41-43.

Pelseneer P., 1920. Les variations et leur hérédité chez les Mollusques. *Mémoires de l'Académie Royale de Belgique*, (2) **5**: 1-826.

Pelseneer P., 1923. Variations dans les Mollusques. *Annales de la Société Royale Zoologique de Belgique*, **54**: 68-78.

Pilsbry H.A., 1892-1894. *Monograph of Polyplacophora*. *In*: Tryon G.W. (ed.), *Manual of Conchology*. Academy of Natural Sciences, Philadelphia, **14**: 1-128, pls 1-30 (1892); i-xxxiv, 129-350, pls 31-68 (1893); **15**: 1-64, pls 1-10 (1893); 65-133, pls 11-17 (1894).

Robertson R.C., 1973. Abnormal Australian chitons (Part 1). *Australian Shell News*, **1**: 11.

Roth B., 1966. Some abnormal chitons from Washington State. *The Veliger*, **9**: 249-250.

Scheuchzer J.J., 1731-1735. *Biblia ex physicis illustrata quibus res naturalis in Scriptura Sacra occurrentes exhibentur*. O. Vandelicorum et Ulmae, 4 vols.

Schwabe E., 2001. Abnormality of shell-plates in *Chiton cumingsii* Frembly, 1827 (Mollusca: Polyplacophora: Chitonidae). *Bollettino Malacologico*, **37**: 5-6.

Schwabe E., 2009. Two cases of abnormalities in shell plates of Polyplacophora (Mollusca). *Chiribotan*, **39**: 182-188.

Sirenko B.I. & Kashenko S.D., 1990. Larval development of *Ischnochiton hakodadensis* Pilsbry (Polyplacophora, Ischnochitonidae) under normal conditions and at salinity changes. *Biologia Morya*, **1**: 43-51.

Sykes E.R., 1900. Malacological Notes. 1. On a three-valved *Ischnochiton*. *Journal of Malacology*, **7**: 164.

Taki Iw., 1932. On some cases of abnormality of the shell-plates in chitons. *Memoirs of the College of Science, Kyoto Imperial University*, (B) **8** (1): 27-64, pl. 2.

Tapparone-Canefri C., 1874. *Zoologia del viaggio intorno al globo della Regia Fregata Magenta durante gli anni 1865-68. Malacologia (Gasteropodi, Acefali e Brachiopodi)*. G.B. Paravia, Torino: 161 pp.

Tucker J.S. & Giese A.C., 1959. Shell repair in chitons. *Biological Bulletin*, **116**: 318-322.

Van Belle R.A., 1983. A propos d'une anomalie exceptionelle chez *Chaetopleura angulata* (Spengler, 1797) (Mollusca: Polyplacophora). *Basteria*, **47**: 55-57.

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