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The teratologies of nudibranchs molluscs (Gastropoda: Nudibranchia): new insights

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ABSTRACT

The term teratology is generally defined as “the study of morphological anomalies of an entire organism or of one or more parts of it”. Regarding the order Nudibranchia, there are only few examples and information of nudibranchs with morphological anomalies. The teratologies are due to environmental or genetic causes, but in any case, they are not lethal and the animals, when reproduce, give birth to perfectly normal offspring.

In the present study several teratological nudibranch specimens, found along the central-eastern coast of Sicily (Italy), were documented. For each finding, information about locality, depth and type of malformation were given. Moreover, possible origins of the anomalies were here discussed. Through this study and the analysis of the scientific literature, it was observed that the most diffuse teratology in the nudibranchs is the bifurcation of the principal eversions of the body. In the specific, the most common teratology in the dorids consists in the bifurcation of the rhinophores, while in the cladobranchs, the most frequent anomalies regard the bifurcation of oral tentacles and cerata.

Keywords: Anomalies; Nudibranchia; Sicily; Teratology

INTRODUCTION

The term teratology, from the French “tératologie”, was coined and used for the first time by the French zoologist Étienne Geoffroy Saint-Hilaire in his work of 1830, titled "De la nécessité et des moyens de créer pour les Monstres une nomenclature rationelle et méthodique" (Merriam-Webster, 2022). Although, this term can present several definitions and facets depending on the areas of use (Clegg, 1971), generally it is defined as “the study of morphological anomalies of an entire organism or of one or more parts of it” (De Vecchi *et al*., 1937). Within the Phylum Mollusca, numerous cases of morphological anomalies have been registered in the scientific literature (e.g. Parenzan, 1967; Poizat, 1987; Perrone, 1992; Soppelsa *et al*., 2005-2006), which can involve both hard (e.g., the shell) and soft parts of the animal (Poizat, 1987). Poizat (1987) subdivided the teratologies in two categories: total or partial absence of parts of the body and malformation of pre-existing structures. The malformations belonging to the first category are due to perturbations occurred during the first phases of larval development, which interrupt the normal course of growth. Instead, the malformations belonging to the second category are probably

caused by damages suffered by the animal after the larval period and, thus, reparable, although in some cases the reconstruction of a given part occurs in an abnormal way, producing teratologies.

Regarding the order Nudibranchia, which represents one of the most fascinating and searched (both by specialists and amateurs) group of marine gastropods (Burn, 2015), there are only few examples and information of nudibranchs with morphological anomalies (Perrone, 1992). In any case, the few specimens reported in literature belong to both the suborders: Doridina and Cladobranchia. In the dorids, the teratologies principally reported are in the rhinophores (Perrone, 1992). These malformations concern almost always the split (or even the tripartition) of the distal part of one rhinophore or the presence of an extra rhinophore (Fischer, 1888; Vayssiere, 1910: Risbec, 1928; Gohar & Soliman, 1963; Barletta, 1980; Perrone, 1992; Lombardo & Marletta, 2021a; Ballesteros *et al*., 2022). Moreover, in the dorids, it was also recorded the presence of additional oral tentacles (Thompson & Turner, 1983); foot protruding from the mantle in species where this should not occur (Perrone, 1992; Lombardo & Marletta, 2021a) and finally strange funnel-shaped protuberances/eversions of the mantle tegument (Lombardo & Marletta, 2021b).

As regards to the cladobranchs, the following cases were reported: entire aberrant specimens (Eliot, 1901; Tardy, 1970; Poizat, 1987); presence of only one rhinophore and oral tentacles with abnormal appearance (Risbec, 1930); splitting of the distal part of one of the rhinophores (Risbec, 1928); rhinophores almost completely smooth in species that should have annulated ones (Schmekel & Portmann, 1982); splitting of one of the two oral tentacles in the middle of its length; formation of an outgrowth on one of the oral tentacles from which two further small oral tentacles originate; bifid cerata and lack of much of the posterior body area (Lombardo & Marletta, 2021b). The teratologies would not appear to be lethal and the animals that present them are active and maintain the usual proper behaviour of the species and, when they reproduce, give birth to perfectly normal offspring (Poizat, 1987).

Recently Lombardo & Marletta (2021b), documented in a brief note some examples of teratological marine Heterobranchia specimens, detected along the central-eastern coast of Sicily. Among these latter, there were also some specimens of nudibranch species.

The aims of the present study are: 1) to show further teratological nudibranch specimens, found along the same area; 2) to increase the knowledge on the several types of teratologies present in this group of marine gastropods.

MATERIALS AND METHODS

The teratological specimens found throughout this study were encountered during several morning (between 9:00 and 11:30 a.m.) scuba dives carried out from October 2018 to January 2022 in some sites located along the central-eastern coast of Sicily (Fig. 1-2): Ognina (37°31’50.4” N – 15°07’10.8” E), Bellatrix (37°32’03.2” N – 15°07’35.2” E), Santa Maria La Scala (37°36’46.5” N – 15°10’31.4” E) Scalo Pennisi (37°38’23.2” N – 15°11’04.6” E) and Acque Fredde (37°38’15.7” N – 15°10’52.1” E). All the specimens were photographed with an Olympus TG-4 underwater camera. The photographs were subsequently analysed to detect all the visible anomalies owned by the animals. For each finding, information about locality, depth and type of malformation are here given. Moreover, possible origins of them are discussed. The systematics followed in this note is that present on WoRMS (2022).

Figures 1-2. Sites along the central-eastern coast of Sicily examined throughout this study

RESULTS

Order Nudibranchia
Suborder Cladobranchia
Family Facelinidae Bergh, 1889
Cratena peregrina (Gmelin, 1791)

On 13rd March 2021 in the site of Santa Maria La Scala, it was found at a depth of 22.4 m a specimen of *C. peregrina* (Fig. 3-4) with most of the body missing. At the posterior end, there was a small tail. The cerata behind the head were normal in appearance and size, while the rearmost group of cerata was present in the form of tiny sketches. Another specimen with a similar anomaly (Fig. 5) was documented on 17th August 2021 in the site of Ognina at 29.4 m of depth. Contrary to the previous one, this animal did not present the tail and had the rearmost cerata slightly more developed and numerous. The end of the body seemed of being cut off.

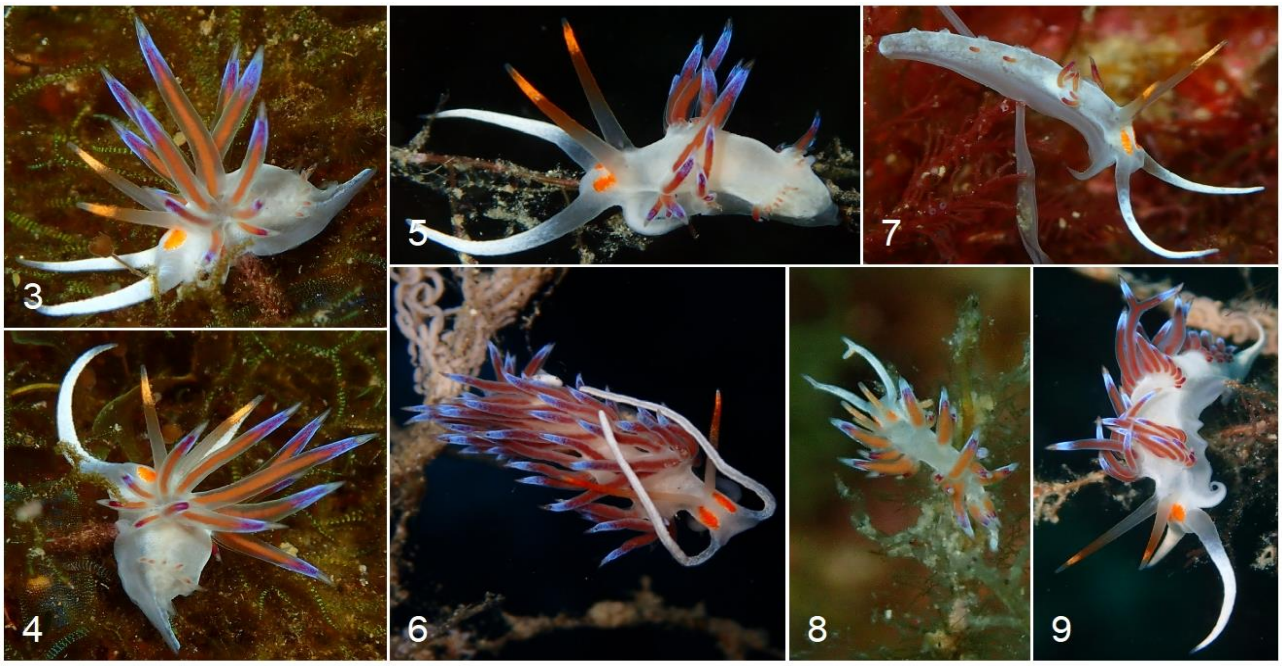
On 5th August 2021 at Santa Maria La Scala, it was encountered a specimen (Fig. 6) at 32.2 m of depth, which presented the oral tentacles totally distressed, with the normal colouring, but longer and thinner. On 4th May 2021, at Scalo Pennisi, a specimen of *C. peregrina* (Fig. 7), which lacked almost all cerata, was found at 23.3 m of depth. The only cerata present were those of the first group (even though of small-medium size) and the third and fourth group owned just one cerata. The position of the groups of cerata were easily visible thanks to the sketches on the notum. The tail was cut off cleanly.

On 5th June 2021, at Ognina, it was documented a small specimen (Fig. 8) at 8.7 m of depth, which presented both the apices of oral tentacles that were bifid.

On 10th May 2021 in the same site, it was detected, at a depth of 15 m, a specimen (Fig. 9) which had a bifid cerata that, bifurcating, gave rise to two identical distal parts.

Family Flabellinidae Bergh, 1889
Edmundsella pedata (Montagu, 1816)

On 4th January 2020 in the site of Ognina, a weird specimen of *E. pedata* (Fig. 10-11) was found at a depth 21.4 m. This individual did not present a well-defined head, which could only be recognised by the presence of propodial tentacles and of a dorsal solitary tentacle. Overall, the anterior part of the body had a disordered and asymmetrical aspect. The frontmost group of cerata (on the left side) was very close to the "pseudo-head". Some cerata were missing.



Figures 3-9. Teratological specimens of *Cratena peregrina* (photos by A. Lombardo).

On 26th May 2020 in the same site, it was observed, at a depth of 4.4 m, a specimen (Fig. 12) that lacked almost all the body. It was truncated sharply at the back. Moreover, the animal lacked almost all the cerata. On the notum it was possible to note some protuberances left by the missing groups of cerata. On the left side of the mollusc's body there was an evident furrow/scorer.

On 22nd May 2020 in the site of Acque Fredde at 26.1 m of depth, it was documented a specimen (Fig. 13), which lacked almost all the cerata, but on the notum the sketches of them were evident. Instead, the specimen, found at Bellatrix on 28th May 2020 at 37.8 m, was completely devoid of cerata (Fig. 14).

On 27th February 2021 at the site of Santa Maria La Scala, it was observed at a depth of 17.8 m an individual (Fig. 15-16) which presented the distal part of the left oral tentacle that was bifid. Each bifurcation had the usual aspect and colouration of the distal part of a normal oral tentacle in this species.

Flabellina affinis (Gmelin, 1791)

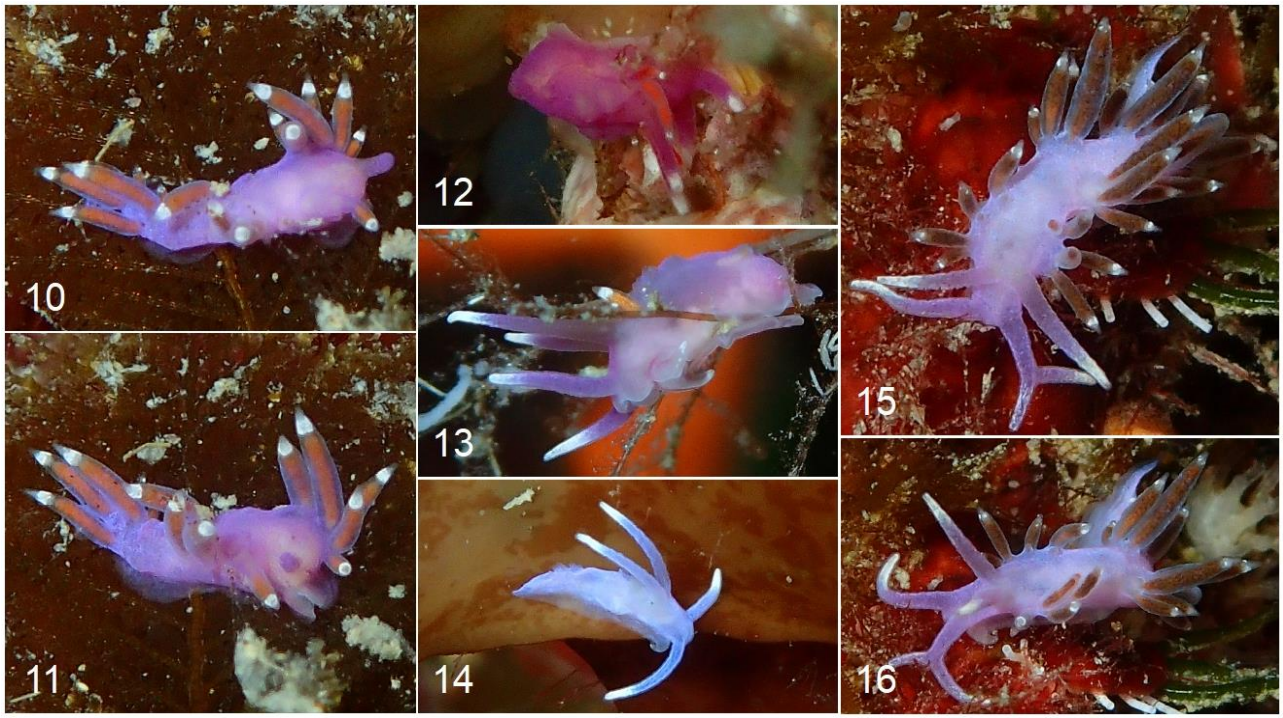
On 5th August 2021 in the site of Santa Maria La Scala, it was found a specimen without most of the body, at a depth of 28.6 m (Fig. 17). This individual was provided only of the head and the area in which there was the first group of cerata. One of the cerata was distally bifid.

Flabellina cavolini (Vérany, 1846)

On 19th June 2021, in the site of Acque Fredde, it was documented at 4.3 m of depth an individual which presented the left rhinophore that was distally bifid (Fig. 18).

Paraflabellina ischitana (Hirano & T. E. Thompson, 1990)

On 9th October 2018 in the site of Santa Maria La Scala, it was detected at a depth of 31.9 m a specimen with three bifid cerata (Fig. 19). In two of them, it was possible to note a difference in the subdivision: in one of them, the branch of the digestive gland (orange coloured and visible for transparency of the tegument of cerata), which originated the bifurcation, was single; while in the other one, instead, there were two divided and parallel branches, within a unique cerata, which separated further up.



Figures 10-16. Teratological specimens of *Edmundsella pedata* (photos by A. Lombardo).

Figures 17-22. Teratologies in *Flabellina affinis* (Fig. 17), *F. cavolini* (Fig. 18), *Paraflabellina ischitana* (Fig. 19), *Nemesignis banyulensis* (Figs. 20-22) (photos by A. Lombardo).

Family Myrrhinidae Bergh, 1905
Nemesignis banyulensis (Portmann & Sandmeier, 1960)

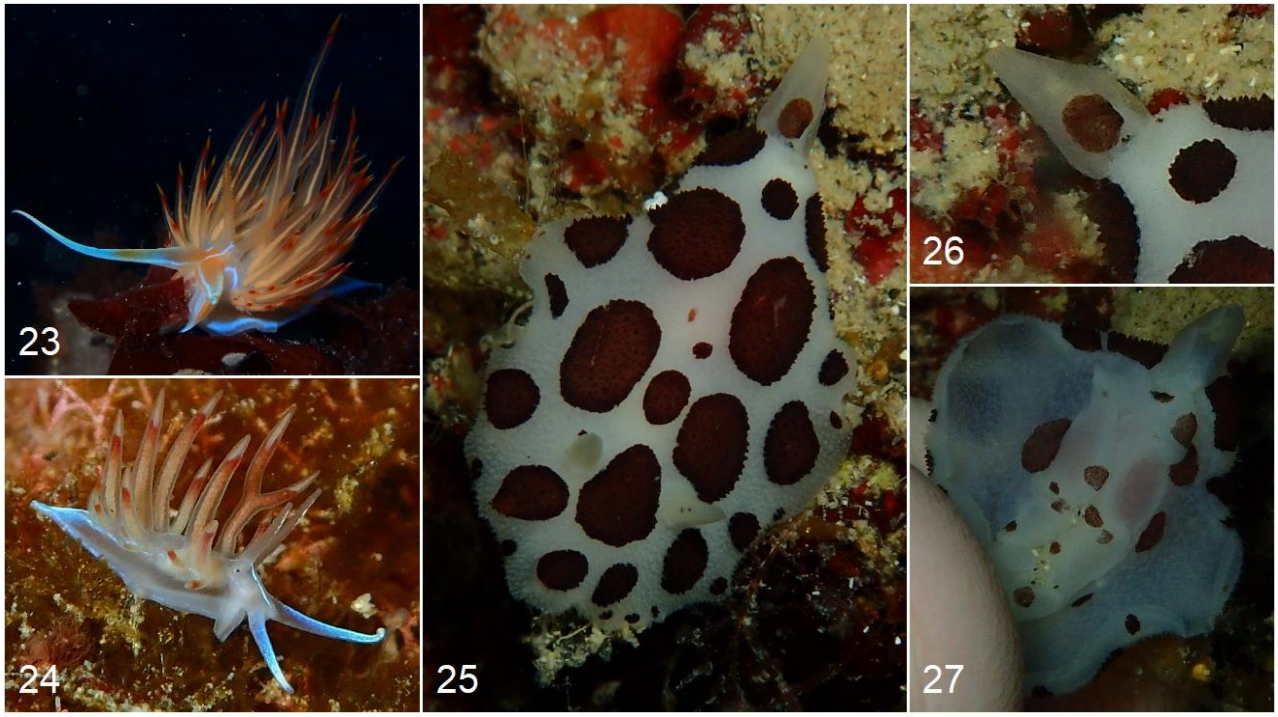
On 5th January 2022 at Santa Maria La Scala, it was observed at 33.1 m of depth a specimen that presented the majority of cerata very tiny and colourless (Fig. 20). The only cerata with a usual aspect were those that were in a more lateral position for each group. On the middle of the notum, it could be noted an evident sunken of the tegument which made the contours of the heart and kidney easily visible (Fig. 21-22). The penis protruded slightly from the genital papilla.

During the same scuba dives, at 33 m of depth, it was encountered another specimen, morphologically normal, which presented one of the cerata that was extremely long (Fig. 23).

On 20th February 2021, in the site of Ognina at 6.2 m of depth, it was observed a small *N. banyulensis* specimen, which had a bifid cerata (Fig. 24). This last bifurcated approximately at half of its length.

Suborder Doridina
Family Discodorididae Bergh, 1891
Peltodoris atromaculata Bergh, 1880

On 4th July 2021 at Ognina, it was documented at a depth of 30.3 m a tiny *P. atromaculata* individual, which presented the posterior part of the foot longer than normal (Fig. 25). This provoked the outflow of the latter from the mantle. The posterior part of the foot was elongated and pointed antero-posteriorly. It presented a brown spot on the dorsal surface, which was greyish-transparent (Fig. 26). The ventral part (Fig. 27) had the same colouration.



Figures 23-27. Teratological specimens of *Nemesignis banyulensis* (Figs. 23-24) and *Peltodoris atromaculata* (Figs. 25-27) (photos by A. Lombardo).

DISCUSSION

The teratologies displayed by the observed specimens can be attributed to environmental or genetic causes. The remarkable shortenings of the body found in 4 observed specimens (2 belonging to *C. peregrina*, 1 to *E. pedata* and 1 to *F. affinis*) and the total or partial lack of cerata in some of the documented nudibranchs (1 belonging to *C. peregrina* and 2 to *E. pedata*) could have a predatory origin (intentional or unintentional). Indeed in literature, it was reported that the principal visual predators of nudibranchs are fishes (especially labrids) and crustaceans (in particular crabs) (Chambers, 1934; Ajeska, 1971; Harris, 1973; Todd, 1981; Rudman, 2009). In fact the shortenings of the body in the observed specimens, presented almost always a clean separation that suggested a bite or a cut of a hypothetic predator (fish or crustacean). It is noteworthy that in none of the specimens the lacking part of the body did not regrow. Instead, regarding the seen specimens with the total or partial lack of cerata, it can be suggested that crabs could be the responsible of this type of wound. Indeed Harris (1973) reported that crabs normally remove the eolids' cerata before consuming their bodies. Moreover, another possible responsible of these wounds could be the tiny crustacean *Calcinus tubularis* (Linnaeus, 1767) (very common in the habitats where these nudibranchs live (authors' pers. obs.)). Indeed, it was reported that this decapod hooks with its claws and preys small marine heterobranchs (Rudman, 2009; Lombardo & Marletta, 2021c). Consequently, it is plausible that these specimens were caught by this crustacean and, through the known autotomy of cerata (Hecht, 1896; Edmunds, 1966), they managed without evident damages to distract or disturb the predator. However, one of the *C. peregrina* specimens without cerata lost a part of its tail (probably the crustacean grasped the nudibranch from this part of the body) during the escape.

The case of *N. banyulensis* specimen almost without cerata, with an evident sunken in the pericardic area (which made easily visible the contours of the heart and the kidney) and with the eversion of the penis is most probably attributable

to the normal senescence process. In fact, Thompson (1976) observed that senescent or moribund nudibranch specimens showed, among other characteristics, eversion of the penis and marked degeneration of the kidney. In addition, these animals had a large anomaly of the digestive gland, whose cell walls tended to detach. Consequently, our specimen, presenting all these characteristics (the second deducible by the evident sinking of the kidney and the third by the lack of many cerata) was probably in an advanced state of senescence and close to death. The finding of the *C. peregrina* specimen with flaccid and long oral tentacles might be caused by the ageing process or by a disease, as in the previous case, but this hypothesis cannot be confirmed.

Another particular teratology is that shown by the specimen of *E. pedata* with a not defined head. In this case, it cannot be stated with certainty whether this anomaly is due to genetic or environmental causes. However, by examining the photos, the body of the animal appears to be damaged on the flanks. Consequently, the cause of this aspect could be predatory. Indeed, it was observed that the fish *Thalassoma pavo* (Linnaeus, 1758) in experimental conditions can attach/probe and spit out several times specimens of *C. peregrina* encountered along the water column (Aguado & Marin, 2007). Consequently, this individual might be attached/probed by a specimen of this fish, badly damaged and then spat out. Subsequently, the damages of the anterior part of the body have been badly healed giving the animal its aberrant appearance.

Throughout this study, 3 encountered animals presented: a bifid oral tentacle (*E. pedata*), both bifid oral tentacles (*C. peregrina*) and a bifid rhinophore (*F. cavolini*). In all cases, the principal axis (oral tentacle or rhinophore) perfectly bifurcated in two identical distal continuations. Consequently, it is not certain if these anomalies were caused by the recovery of damaged parts or by genetic causes. The most found anomaly in the observed cladobranchs was surely the bifurcation of cerata, indeed specimens of 4 different species (*C. peregrina*, *F. affinis*, *N. banyulensis* and *P. ischitana*) presented this teratology. Regarding the individuals of *C. peregrina* and *F. affinis*, the cerata distally bifurcated. Instead, in the case of the small individual of *N. banyulensis*, the cerata bifurcated approximately at the half of its length. The specimen of *P. ischitana* presented even three bifid cerata. These latter types of teratologies are probably of genetic origin. Indeed, it is likely that, as highlighted by Lombardo & Marletta (2021b), if the animals would be subjected to an attach in that part of the body, they should have lost more cerata and thus it should have been noted an evident difference in size between the new cerata and those not lost.

Another case of probable genetic anomaly is that observed in the specimen of *N. banyulensis* with an excessively long cerata. Indeed, it presented all the other cerata of the usual length and without any damages. The last documented anomaly is that owned by a specimen of *P. atromaculata*, whose foot is longer posteriorly and thus exteriorly visible. In literature, this teratology was previously reported by Perrone (1992) and Lombardo & Marletta (2021a). In both cases, the authors did not provide explanations or hypotheses on the origins of this anomaly. By observing, ventrally, the foot of our specimen, it appears that there were not signs of wounds. Consequently, this anomaly is probably due to genetic causes.

In conclusion, through the analysis of the scientific literature (see above) and the observations carried out through the present work, it is clear that the most diffuse teratology in the nudibranchs (excluding entire teratologic individuals observed by Eliot (1901), Tardy (1970) or Poizat (1987) and the anomalies due to wounds) is the bifurcation of the principal eversions of the body. In the specific, the most common teratology in the dorids consists in the bifurcation of the rhinophores, while in the cladobranchs, the most frequent anomalies regard the bifurcation of oral tentacles and cerata.

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Teratologija kod puževa golaća (Gastropoda: Nudibranchia): nova saznanja

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SAŽETAK

Termin teratologija se generalno definiše kao „proučavanje morfoloških anomalija cijelog organizma ili jednog ili više njegovih djelova“. Što se tiče reda Nudibranchia, postoji samo nekoliko primjera i podataka o poževima golaćima sa morfološkim anomalijama. Teratologije su uzrokovane ekološkim ili genetskim uzrocima, ali u svakom slučaju nisu smrtonosne i te životinje, kada se razmnožavaju, rađaju potpuno normalno potomstvo.

U ovom radu dokumentovano je nekoliko teratoloških primjeraka puževa golaća, pronađenih duž centralno-istočne obale Sicilije (Italija). Za svaki nalaz date su informacije o lokalitetu, dubini i vrsti malformacije. Osim toga, diskutovano je i moguće porijeklo anomalija. Ovom studijom i analizom naučne literature je uočeno da je kod puževa golaća najzastupljenija teratologija bifurkacije glavnih isturenih djelova tijela. Tačnije, najčešća teratologija kod nadreda Doridina se sastoji u račvanju rinofora, dok se kod nadreda Cladobranchia najčešće anomalije odnose na račvanje oralnih pipaka i cerata.

Ključne riječi: anomalije; puževi golaći; Sicilija; teratologija