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Morphological abnormalities in the stauromedusa *Haliclystus auricula* (Cnidaria) and their possible causes

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Morphological abnormalities were observed in a population of the stauromedusa Haliclystus auricula *in southern Chile. A total of 144 abnormal specimens was observed out of 3790 Stauromedusae sampled. The following abnormalities are described: individuals lacking arms (73%), with more than eight anchors (11%), more than eight arms (8%), lacking anchors (4%) and one individual with tentacles in abnormal locations. An individual with two peduncles, one with two mouths and one twin-like individual are recorded for the first time in this species. Their possible causes are discussed.*

Keywords: abnormalities, Medusae, *Haliclystus*, morphological variation, Stauromedusae

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The order Stauromedusae are small polyp-like medusae which live attached to algae or other objects by means of a stalk-like peduncle. Members of this order are typically described as having an umbrella that draws out into eight simple (e.g. *Haliclystus auricula*; Clark, 1878) or four bifurcated (e.g. *Sasakiella cruciformis*; Uchida, 1929) arms, each tipped with a bunch of short tentacles. On the exumbrellar side of the margin, between each pair of arms are eight adhesive anchors. As with other animals, morphologically abnormal medusae may be present in the population (Uchida, 1928). Despite descriptions of the order dating back to the late 1700s (Müller, 1776), morphological abnormalities in this group have, however, rarely been reported. Individuals with abnormal symmetry are the most commonly reported, with an excess of arms or anchors (e.g. *Haliclystus auricula* with up to 12 arms and 12 anchors; Uchida & Hanaoka, 1934). Organisms which seemed to be damaged and lack parts of their body such as arms or tentacles have been recorded by Amor (1962) and Gwilliam (1956). A more unusual account is the description of an abnormal twin-type individual of *Lucernaria quadricornis* (Berrill, 1962), which had two nearly separate individuals, the peduncle of the smaller one arising from the peduncle of the larger. Some of these abnormalities (summarized in Table 1) have been attributed to the physical action of waves (Amor, 1962) or predation (Uchida & Hanaoka, 1933), removing body parts (Amor, 1962) which could later be regenerated (Hornell, 1893; Berrill, 1962).

Records of morphological variation and abnormalities present in organisms are essential for understanding and increasing our knowledge of their taxonomy, biology and ecology. This is especially true for the order Stauromedusae, where taxonomic revisions of some groups (e.g. the genus *Haliclystus*; Hirano, 1997) are still necessary and little information about their biology and ecology exists. If a morphologically abnormal specimen is observed and it has not been previously described in the literature, it may lead to confusion and erroneous identification. Abnormal organisms may also be indicators of ecological processes, such as disturbances, affecting populations. The aim of this work is to describe the morphological abnormalities and their relative abundance in a population of *Haliclystus auricula* in southern Chile and discuss their possible causes.

Between November 2001 and November 2002, whilst researching the population biology, habitat and diet of the stauromedusa *Haliclystus auricula* (Zagal, 2004a, b), 3790 Stauromedusae were sampled (see Zagal, 2004b for detailed methodology) and their morphological abnormalities recorded and photographed.

Abnormalities were present in 144 medusae, 4% of the sample. The eight types of abnormalities observed and their relative abundances are summarized in Table 2 and Figure 1. The most frequent abnormality recorded (74% of all abnormalities) consisted in medusae which seemed to be damaged, lacking some or all arms. These included an individual with no arms and with only one anchor (Figure 1A) and medusae with one to seven arms (Figure 1B–D) instead of eight. In most cases (Figure 1A–C), missing arms seemed to have been removed, leaving an empty space where one would expect the arm to be. In other cases (Figure 1D) only a change in symmetry of the animal was observed, with no vacant spaces between arms. Medusae with 9–12 anchors instead of eight made up 11% of the abnormalities recorded. These medusae usually had two individual anchors or joint heart-shaped anchors between one or more arms (Figure 1E). Eleven (8%) medusae with 9–12 arms were observed (Figure 1F–H). These medusae had pentamerous (Figure 1F) or hexamerous symmetry (Figure 1G) or a second calyx apparently growing from the side of the main

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Table 1. Known stauromedusan abnormalities.

Abnormality	Stauromedusa species	Location	Records
More than eight arms	*Haliclystus auricula* Rathke, 1806	Argentina	Mianzan, 1989
		Chile	Current record
	Haliclystus borealis Uchida, 1933	Japan	Uchida & Hanaoka, 1934
	Thaumatoscyphus distinctus Kishinouye, 1910	Japan	Uchida & Hanaoka, 1933
	Sasakiella cruciformis Okubo, 1917	Japan	Uchida, 1928, 1929
Lacking arms	*Haliclystus auricula* (Rathke, 1806)	Argentina	Amor, 1962
		Chile	Current record
	Haliclystus salpinx Clark, 1863	North-west Pacific	Gwilliam, 1956
More than eight anchors	*Haliclystus auricula* (Rathke, 1806)	Argentina	Amor, 1962
		Chile	Current record
	Haliclystus borealis Uchida, 1933	Japan	Uchida & Hanaoka, 1934
	Haliclystus californiensis Gwilliam, 1956	North-west Pacific	Gwilliam, 1956
	Haliclystus octoradiatus Lamarck, 1816	Not specified	Hornell, 1893
	Thaumatoscyphus distinctus Kishinouye, 1910	Japan	Uchida & Hanaoka, 1933
Lacking anchors	*Haliclystus auricula* (Rathke, 1806)	Argentina	Mianzan, 1989
		Chile	Current record
	Haliclystus octoradiatus (Lamarck, 1816)	Not specified	Hornell, 1893
Two peduncles	*Haliclystus auricula* (Rathke, 1806)	Chile	Current record
Two mouths	*Haliclystus auricula* (Rathke, 1806)	Chile	Current record
Twin-type individual	*Lucernaria quadricornis* (Müller, 1776)	North-east Pacific	Berrill, 1962
	Haliclystus auricula Rathke, 1806	Chile	Current record
Tentacles in abnormal locations	*Kishinouyea corbini* Larson, 1980	Puerto Rico	Larson, 1980
	Haliclystus auricula (Rathke, 1806)	Chile	Current record
Not specified	*Haliclystus auricula* (Rathke, 1806)	North-west Pacific	Gwilliam, 1956

calyx (Figure 1H), with its own arms, tentacles, anchors and gonads. Less frequent abnormalities include individuals lacking 1–3 anchors between some of their arms (4%), medusae with two peduncles (1%; Figure 1I) and one individual with two mouths (Figure 1J) instead of one. An individual with a bunch of tentacles growing from the side of its calyx instead of the arm was also found (Figure 1K). One twin-type specimen consisted of two nearly complete individuals sharing the same peduncle, with a smaller medusa growing out of the larger one at the base of its calyx (Figure 1L).

Eight morphological abnormalities were seen in *H. auricula*. The most frequently observed was medusae which seemed to be damaged, lacking arms and anchors. This is most probably caused by predators or physical disturbance by the environment such as wave-action. Known predators of Stauromedusae include fish (Davenport, 1998) and pycnogonids (Uchida & Hanaoka, 1933). The nudibranchs *Hancockia schoeferti* and *Thecacera darwini* and the fish *Myxodes viridis* were frequently observed near or on the same algae as *H. auricula*, but no evidence was found of them eating Stauromedusae. Medusae with abnormal symmetry have been frequently reported in other cnidarians such as the medusa *Aurelia* (Gershwin, 1999) and the hydromedusae *Gonionemus* (Hargitt, 1901) and *Olindias sambaquiensis* (Nogueira Junior & Haddad, 2006). It is unclear whether variations in symmetry are caused by genetic, environmental, or developmental factors, or some combination of these (Gershwin, 1999). Stauromedusae with two peduncles or two mouths are described for the first time and a twin-like individual for the first time in this species. These abnormalities, together with a medusa with a second calyx apparently growing out of the first one, raise the question of whether *H. auricula* might be able to reproduce asexually. Collins & Daly (2005) have already raised this question previously after the observation of dense aggregations of the deepwater species *Lucernaria janetae* and a juvenile attached to the base of the peduncle of a large adult. The only records of asexual reproduction in the order Stauromedusae are for *Stylocoronella riedli* and *S. variabilis* (Kikinger & Salvini-Plawen, 1995) where planuloids are produced by budding of the calyx or special tentacles, respectively. Asexual reproduction by longitudinal fission or budding of the stauromedusa itself into new polyps has, however, never been recorded. The presence of more body parts than normal may also be the result of regenerating injured tissue. Although this has been suggested previously by Hornell (1893) and Berrill (1962) and is well-developed in scyphozoa (Arai, 1997), it has not been tested experimentally in Stauromedusae. The abnormalities observed may also reflect a lack of genetic variation in the population. Dispersal in *H. auricula* seems to be limited to detachment and re-attachment of the peduncle in adults and the development of crawling larvae during sexual reproduction (Otto, 1978) which may restrict dispersal and gene-flow. Future studies in this group

Table 2. Frequency of occurrence (N) and relative abundance (R_a %) of morphological abnormalities observed in *Haliclystus auricula*.

Abnormality	N	R_a %
More than eight arms	11	7.6
Lacking arms	106	73.6
More than eight anchors	16	11.1
Lacking anchors	6	4.2
Two peduncles	2	1.4
Two mouths	1	0.7
Twin-type individual	1	0.7
Tentancles in abnormal locations	1	0.7
Total abnormal Stauromedusae	144	
Total Stauromedusae sampled	3790	

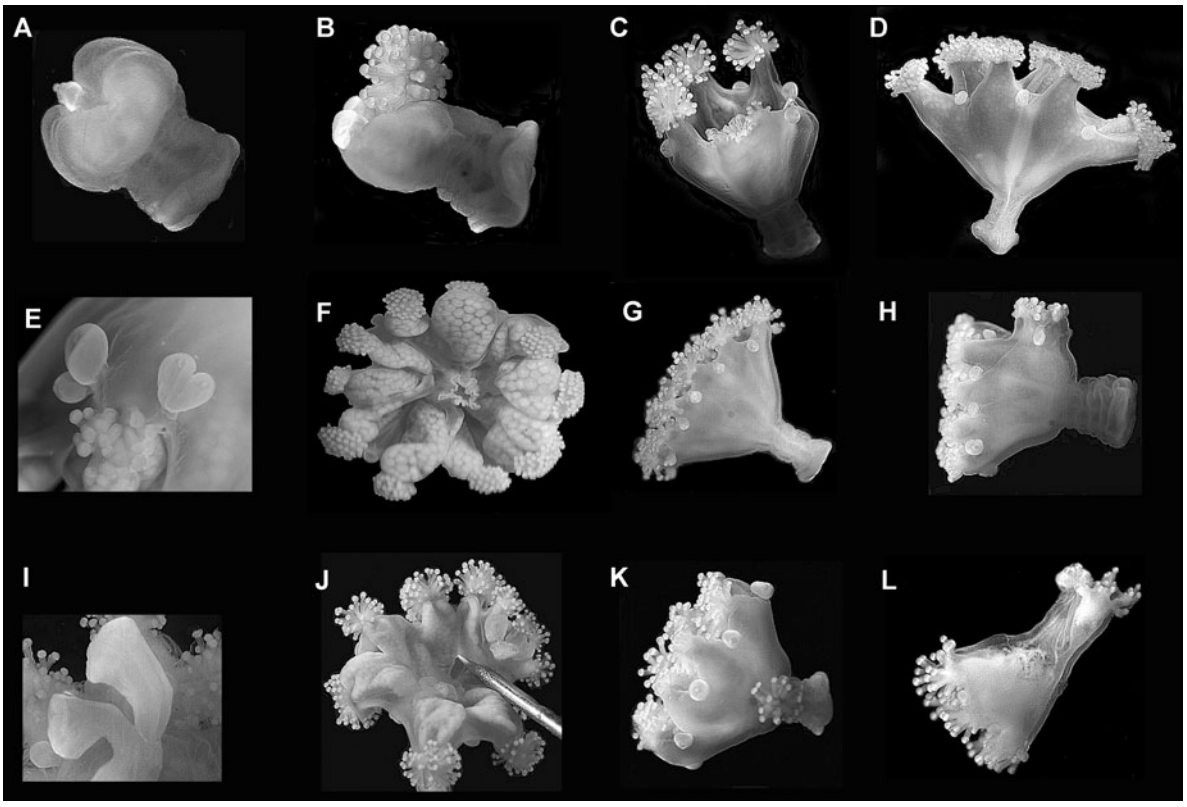

Fig. 1. Morphological abnormalities in the stauromedusa *Haliclystus auricula* (umbrella height): (A) no arms (2 mm); (B) one arm (1.9 mm); (C) five arms (5.5 mm); (D) seven arms (6 mm); (E) double anchors (6.8 mm); (F) ten arms (7 mm); (G) 12 arms (5 mm); (H) 12 arms (5.1 mm); (I) two peduncles (5.3 mm); (J) two mouths (5.5 mm); (K) tentacles in abnormal location (6.1 mm); and (L) twin-type individual (larger medusa, 2 mm).

are necessary to test whether the abnormalities found are environmentally induced, caused by a lack of genetic variation or a combination of these two. It is unclear whether the abnormalities shown in this study are within the normal morphological variation of *Haliclystus auricula*. The geographical range of this species includes the North Pole, Arctic Ocean, North Atlantic (Y.M. Hirano, personal communication), Pacific coast of Chile (Quezada, 1970; Zagal & Hermosilla, 2001) and the Atlantic coast of Argentina (Amor, 1962). To date, only Hirano (1997) has addressed the need for a taxonomic revision of the genus *Haliclystus* and has been capable of identifying many specimens of the *Haliclystus auricula* morph. Genetic studies would be useful in determining the true geographical range of *Haliclystus auricula* and in determining the range of morphological variation in the species.

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