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The presumed shelled juvenile of the parasitic gastropod *Entocolax schiemenzii* Voigt, 1901 and its holothurian host *Chiridota pisanii* Ludwig, 1886*

(Gastropoda, Entoconchidae – Holothuroidea, Chiridotidae)

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Four small shelled gastropods were found externally on the body wall of an apodid holothurian (*Chiridota pisanii* Ludwig, 1886), which was collected in the southern Chilean fjord region. Based on shell morphology and the host species we address these gastropods as the shelled juveniles of *Entocolax schiemenzii* Voigt, 1901, which as adult is a highly modified endoparasite in *Chiridota pisanii*. The holothurian host, as well as the juvenile parasites are thoroughly described, including a SEM study of the holothurian calcareous ring, the calcareous deposits and the juvenile gastropod shell. Furthermore, a detailed 3-D reconstruction of the juvenile for the first time allows a better understanding of its internal organisation.

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Introduction

Parasitic gastropods, in the majority eulimids, associated with Echinodermata as their hosts, are known from all major echinoderm taxa. All transitions, from simple ectoparasites to highly modified endoparasites occur. In his excellent review on the eulimid taxa associated with Echinodermata, Warén (1983) lists 33 species from 15 genera that parasitize on or in Holothuroidea, including the genus *Entocolax* Voigt, 1888 with altogether six described species (Tab. 1). As adults shell-less and highly modified, these endoparasites live in the coelomic cavity of apodid holothurians, where they are either attached to the body wall or to the intestine of their host (see Jangoux 1987: 220-222). Lützen (1968) outlined the morphology of the adults as follows: they are more or less vermiform, have a rudimentary intestine and a central cavity, called pseudopallial cavity, where the egg capsules are brooded; a visceral sac containing the ovary protrudes into the pseudopallial cavity which communicates via a small siphon with the exterior.

As opposed to the highly modified morphology of adult *Entocolax* specimens, the juveniles correspond to the usual gastropod bauplan (e.g. Schwanwitsch 1917, Heding 1934, Heding in Heding & Mandahl-Barth 1938, Iwanow 1945, Schwanwitsch 1946). In his elaborate study on the morphology of *E. schwanwitschi* Heding in Heding & Mandahl-

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Barth 1938 (= *E. ludwigi* sensu Schwanwitsch 1917), Schwanwitsch (1917) also describes the morphology of the juveniles of this species in detail. Shelled juveniles have been reported for all *Entocolax* species (see Tab. 1) except for *E. schiemenzii* Voigt, 1901 and *E. chiridotae* Skarlato, 1951, where the juveniles are unknown.

Herein, we present the juveniles of a gastropod found externally on the body wall of the apodid holothurian *Chiridota pisanii* Ludwig, 1886, which was collected in the southern Chilean fjord region. So far, parasitism on *C. pisanii* is known only from a single eulimid gastropod, *Entocolax schiemenzii*, to which we assign the four juveniles.

Records of *Chiridota pisanii* are not rare and the species has been described in detail (e.g. Ludwig 1886, 1898a, Ekman 1925, Heding 1928). The current knowledge on the morphology of the holothurian host is complemented by a detailed description and figures of the calcareous ring plates and figures and in-depth measurements of the calcareous deposits, which so far have been lacking.

Materials and methods

Host. Small pieces of body wall were macerated in a 12.5 % sodium hypochlorite solution to gain the calcareous deposits. These were rinsed several times in distilled water, then air-dried and finally mounted in Canada balsam on slides. The calcareous deposits were analysed with a Leitz microscope equipped with a video camera (380 USB 2.0 Spacec@m) and the software AxioVision LE. For SEM examinations (Scanning Electron Microscope) the calcareous deposits were transferred to aluminum stubs, sputtered with gold and studied in a LEO 1430 VP Scanning Electron Microscope.

Parasite. The juvenile gastropods were removed from the host's body wall with the aid of a scalpel. For SEM examinations of the shell, one specimen was handled as described in Schwabe and Ruthensteiner (2001). To enable thorough examination, the shell was attached to a needle, which was glued to a stub. For histology, one specimen was embedded in Spurr's medium according to the method of Spurr (1969) and serially sectioned in 1.5 µm steps. The 3-D reconstruction was done with the software Amira 3.1.1. Pictures of all slices were taken, combined to a stack and afterwards aligned with the "slice aligner". The organs on every third slice were marked manually, then connected with the "interpolate" tool and finally the surface of each organ was reconstructed using the "surface gen" and the "smooth surface" tool.

The investigated material is deposited in the Zoologische Staatssammlung München (ZSM). Individual numbers (JMB-) are assigned to holothurian specimens, to allow confident recognition of specimens within a lot.

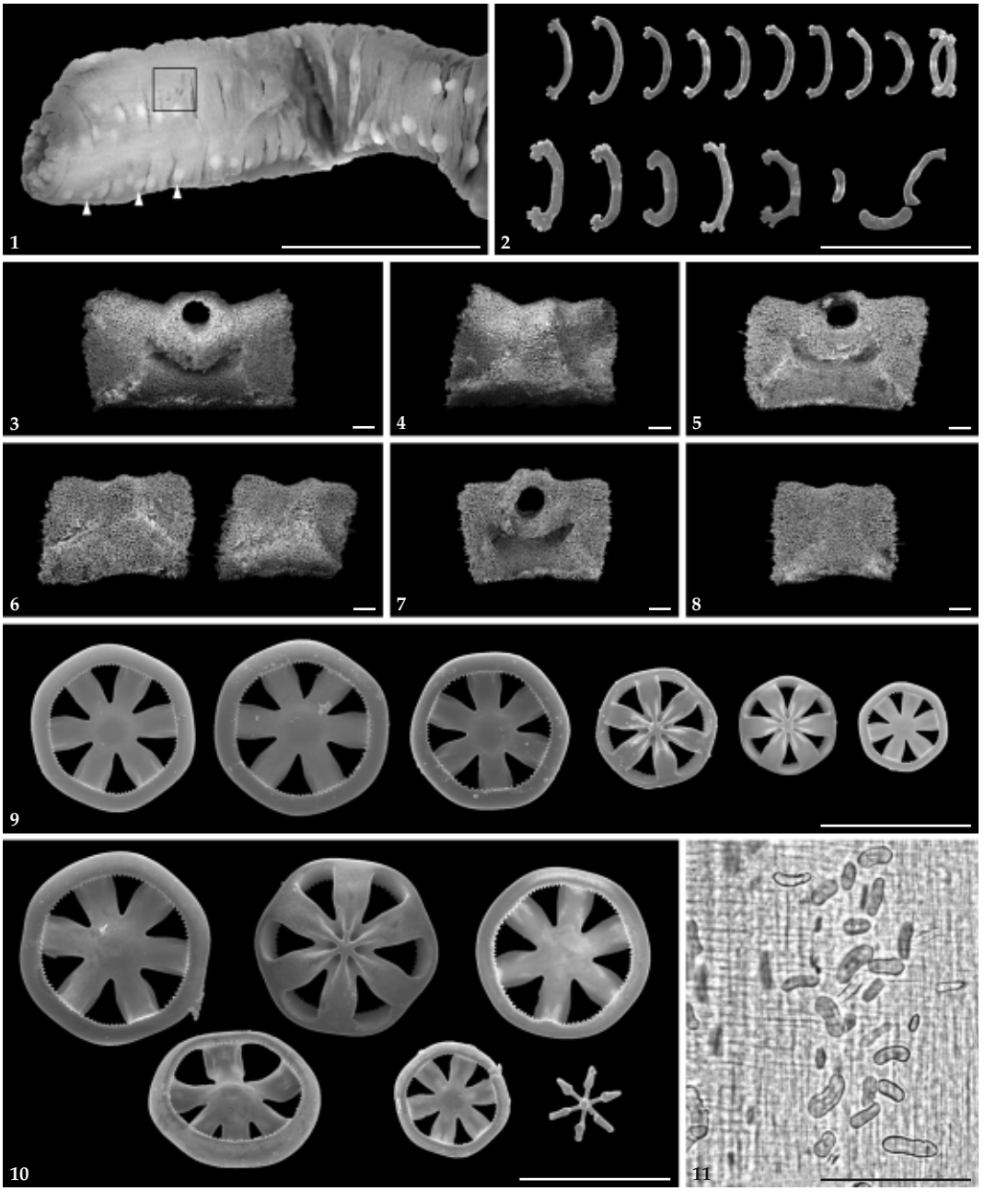
Results and Discussion

Host

Class Holothuroidea de Blainville, 1834, Order Apodida Brandt, 1835, Family Chiridotidae Østergren, 1898, Genus *Chiridota* Eschscholtz, 1829.

Tab. 1. *Entocolax* Voigt, 1888 species, their holothurian hosts, their distribution and reports of juvenile shells.

Species	Host	Distribution	Juvenile shells
E. chiridotae Skarlato, 1951	*Chiridota pellucida* (Vahl, 1806)	Sea of Japan	no juveniles reported
E. ludwigii Voigt, 1888	*Myriotrochus rinkii* Steenstrup, 1851	Greenland	Heding & Mandahl-Barth (1938: 15, figs 16-18)
E. rimskykorsakovi Iwanow, 1945	*Myriotrochus mitsukurii* Ohshima, 1915	Sea of Japan	juveniles only sparsely described, shell mentioned
E. schiemenzii Voigt, 1901	*Chiridota pisanii* Ludwig, 1886	SE Pacific (Chile)	**herein**
E. schwanwitschi Heding in Heding & Mandahl-Barth, 1938	*Myriotrochus eurycyclus* Heding, 1935	Kara Sea	Schwanwitsch (1917: 39, pl. 2, figs 32-33); Heding & Mandahl-Barth (1938: 15, figs 16a-18a)
E. trochodotae Heding, 1934	*Trochodota purpurea* (Lesson, 1830)	Southern South America or Falkland Islands	Heding (1934: 213, fig. 14); Heding & Mandahl-Barth (1938: 9)



Figs 1-11. *Chiridota pisanii* Ludwig, 1886. **1.** Anterior third of specimen infested with *Entocolax schiemenzii* Voigt, 1901, box indicates position of four parasites (see also Fig. 19), arrowheads point on wheel papillae. **2.** Tentacular rods. **3-7.** Plates of calcareous ring. **3.** Mid-ventral radial plate. **4**. Left ventral interradial plate. **5.** Left ventral radial plate. **6.** Left lateral interradial plates. **7.** Left dorsal radial plate. **8.** Mid-dorsal interradial plate. **9.** Wheel deposits from anterior body wall. **10.** Wheel deposits from posterior body wall. Star-shaped structure on lower right is a developing wheel. **11.** Miliary granules of longitudinal muscles. Scale bars: Fig. 1: 10 mm, Figs 2-11: 100 µm.

Chiridota pisanii Ludwig, 1886
Figs 1-12

Chirodota pisanii [sic!] Ludwig, 1886: 29, pl. 2 (fig. 14). – Lampert 1889: 851.

Chiridota pisanii, Ludwig 1892a: 359; 1892b: 350, pl. 16 (figs 1-9); 1898a: 71; 1898b: 445; Perrier 1905: 79; Clark 1908: 29, 118; Ekman 1925: 143, fig. 37; Heding 1928: 297, fig. 62 (1-9); 1931: 682, fig. 14; Deichmann 1947: 347; Pawson 1964: 464; 1969: 140; O'Loughlin 2002: 298 [partim: Tierra del Fuego specimens].

Chirodota purpurea [sic!] Théel, 1886: 15, pl. 2 (fig. 1). – Lampert, 1889: 851 [non *Holothuria purpurea* Lesson, 1830].

Chiridota purpurea, Ludwig, 1892a: 359, pl. 1 (fig. 5) [non *Holothuria purpurea* Lesson, 1830].

Anapta fallax Ludwig, 1898a: 70 [non *Anapta fallax* Lampert, 1889].

Type material. Chile, De Los Chonos, Puerto Lagunas, [45°17'S 73°43'W], coll. G. Chierchia, Dec. 1882, in sand and under stones (whereabouts unknown, 8 syntypes).

Material examined. Chile, Los Lagos, Caleta Gonzalo, 42°33'S 72°36'W, 15-25 m, coll. V. Häussermann and G. Försterra, 17 Jan. 2000 (ZSM Ev20043114, 1 specimen infested with *Entocolax schiemenzii*). Chile, Magallanes y Antartica Chilena, Cabo Direccion, 52°20.98'S 69°29.13'W, intertidal zone: coll. J. M. Bohn and M. Schrödl, 26 Feb. 2002, in tide puddles under stones on a muddy bottom (ZSM Ev20043115, 10 specimens without parasites); coll. J. M. Bohn and E. Schwabe, 09 Apr. 2005, same habitat (ZSM Ev20043137, 3 specimens without parasites).

Description

Investigated specimens up to 68 mm long (-130 mm Ludwig 1898b), width close to calcareous ring 6.3 mm (Fig. 1). Preserved specimens dirty white to pinkish. Alive, specimens dark red ("crimson" Ludwig 1898b, "carmine" Ekman 1925, "purplish" Deichmann 1947), shallow water specimens may lack reddish pigment (Deichmann 1947).

Tentacles 12, with 4-7 pairs of lateral digits, which get continuously longer from proximal to distal. Calcareous deposits of tentacles bracket-shaped rods with more or less branched ends (Fig. 2), sometimes with knob like swelling close to middle. On average rods are 45.8 µm long and range from 16 to 69 µm (Tabs 2, 3).

Calcareous ring (Figs 3-8) consists of 5 radial and 7 interradial plates. Left and right dorsal interradius each with two interradial plates (Fig. 6). All radial plates perforated for passage of nerve (Figs 3, 5, 7). According to Heding (1928, 1931), mid-ventral radial plate somewhat variable, sometimes perforated for passage of nerve, sometimes only with anterior notch.

Gonad consists of tuft of few, thick, long, sometimes branching tubules on both sides of dorsal mesentery. Sexes separate (Ludwig 1898a, Heding 1928). Polian vesicles 4-11 (-16, Théel 1886). Stone canal single. Intestine with large loop, bending close to anterior and posterior end of specimen. Single ciliated urns at base of mesenteries, numerous in mid-dorsal and left dorsal interradius, scarce in right ventral interradius.

Calcareous deposits of body wall chiridotid type wheels, gathered together in papillae, arranged in single interradial rows (Fig. 1: arrowheads). Papillae usually distinct in dorsal interradii (at least in mid-dorsal interradius), inconspicuous or lacking in ventral interradii. Some specimens only have one distinct row in mid-dorsal interradius, while others have distinct rows in all three dorsal interradii. Ekman (1925) even reported on specimens with two rows of papillae in mid-dorsal interradius. Size of papillae variable, according to Heding (1928) up to

Tab. 2. *Chiridota pisanii* Ludwig, 1886. Measurements of tentacular rods and wheel deposits from anterior and posterior parts of body of four specimens: means, standard deviations (in parentheses) and range. **n**, number of measurements; **tr_l, µm**, length of tentacular rods; **w_d, µm**, diameter of wheels; **w_s, n**, number of spokes per wheel.

Parameter	Specimen			
	ZSM Ev20043114	ZSM Ev20043115		
		JMB-01326	JMB-01632	JMB-01633
tr_l, µm	49.1 (±9.7) 34-69 [n=50]	42.1 (±6.6) 27-60 [n=50]	43.9 (±11.0) 16-63 [n=50]	47.9 (±9.5) 26-67 [n=50]
w_d, µm (anterior) w_s, n (anterior)	86.7 (±18.6) 43-121 6.0 (±0) 6 [n=50]	101.9 (±6.8) 82-115 6.5 (±0.6) 6-8 [n=27]	90.0 (±10.0) 65-109 6.3 (±0.5) 6-8 [n=50]	98.3 (±8.7) 76-117 6.1 (±0.4) 5-7 [n=50]
w_d, µm (posterior) ws, n (posterior)	107.3 (±20.5) 65-147 6.0 (±0.2) 6-7 [n=50]	115.5 (±7.0) 104-134 6.3 (±0.5) 6-8 [n=27]	94.4 (±9.0) 70-110 6.1 (±0.2) 6-7 [n=50]	105.0 (±8.1) 90-125 6.1 (±0.4) 6-8 [n=50]

2.3 mm in diameter, but papillae may also merge to form longitudinal band up to 11 mm long (Ekman 1925).

Wheel deposits (Figs 9-10) mean diameter of about 100 µm and range from 43 to 147 µm. Wheels from anterior end of body on average somewhat smaller than wheels from posterior end. Spokes usually 6, only few wheels with 7 or 8. Serration on inner side of wheel continuous. For details of wheel measurements see Tabs 2 and 3.

Calcareous deposits of longitudinal muscles oval to elongated, sometimes curved, often rod-like miliary granules (Fig. 11), 14-49 µm long (Tab. 3).

Distribution (Fig. 12). Pacific and Atlantic coast of southern South America (south of 42°S), Falkland Islands; intertidal zone to 102 m.

Habitat. Prefers sediment bottoms, primarily muddy or sandy, rarely also on seaweeds: *Macrocystis* fronds and holdfasts (Pawson 1964). These sediment bottoms are often covered with stones or boulders: gravel and clay, mixed with mud and covered with boulders or sand gravel and muddy clay covered with boulders or boulders and stones on sand (all from Pawson 1969), underneath which the animals seem to live: in sand under stones (Ludwig 1898a, Ekman 1925) or on a muddy bottom under stones (this study).

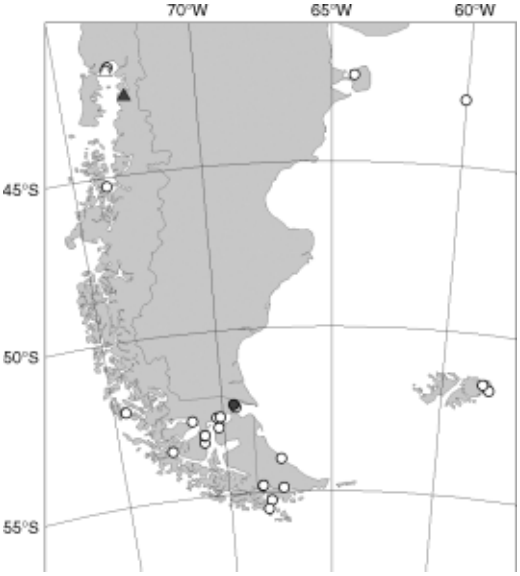


Fig. 12. Distribution of *Chiridota pisanii* Ludwig, 1886 (○,●) and its parasite *Entocolax schiemenzii* Voigt, 1901 (△,▲). Filled labels indicate investigated material, all other records are from literature. (Distribution data have been compiled from several sources, see references in synonymy of *C. pisanii*)

Remarks. The specimens from both localities (Caleta Gonzalo and Cabo Direccion) in most details correspond to the descriptions given by earlier authors. Though records of this species are not rare, figures and measurements of the calcareous deposits are scarce (see Tab. 3). The size range given by Ekman (1925) for wheel deposits fit very well with our measurements (Tab. 3). The same is true for the sizes of wheel deposits, tentacular rods and miliary granules as presented by Heding (1928) or of the tentacular rods as given by Pawson (1964).

Contrary, wheel deposits of the Falkland Island specimens collected by the Challenger Expedition (Théel 1886) are conspicuously larger (140-160 µm, see Tab. 3). In the current specimens, only three out of 354 wheels have a diameter larger than 140 µm. Such striking differences in size ranges of wheel deposits usually are thought to indicate different species. On the other hand, there can be little doubt that *Chiridota pisanii* does also occur at the Falkland Islands, since some of the specimens investigated by Ekman (1925) originated there, and the measurements presented by Ekman for wheel deposits are very close to ours.

Tab. 3. *Chiridota pisanii* Ludwig, 1886. Measurements of tentacular rods, wheel deposits and miliary granules of the investigated specimens compared to published measurements compiled from different sources: means, standard deviations (in parentheses) and range. **mg_l, µm**, length of miliary granules; **n**, number of measurements; **tr_l, µm**, length of tentacular rods; **w_d, µm**, diameter of wheels; [1], length of tentacular deposits (fig. 62.8-9) and miliary granules (fig. 62.3-4) calculated from Heding's fig. 62; [2], Tierra del Fuego specimens described in O'Loughlin (2002).

Parameter	Source					
	Present study	(1886)	(1925)	(1928)	(1964)	(pers. comm.)[2]
tr_l, µm	45.8 (±9.7) 16-69 [n=200]	– –	– –	– 32-63[1]	50 –	– 32-48
w_d, µm	98.7 (±15.3) 43-147 [n=354]	– 140-160	– 80-140	– 70-130	– –	– 72-104
mgl, µm	29.5 (±7.3) 14-49 [n=100]	– –	– –	– 24-44[1]	– –	– 24-32

The measurements given by O'Loughlin (2002) for specimens from Tierra del Fuego and Heard Island also differ to some extent from our own. This is mainly based on the fact that measurements from both localities are presented as a mix (O'Loughlin pers. comm.). If measurements of calcareous deposits from each locality are considered apart, it becomes evident that the Heard Island specimens may represent a different species, closely related to *Chiridota pisanii*, which will be described by O'Loughlin in near future (pers. comm.). The Tierra del Fuego specimens on the other hand seem to be conspecific with our specimens. Sizes of calcareous deposits are very similar to our own (see Tab. 3).

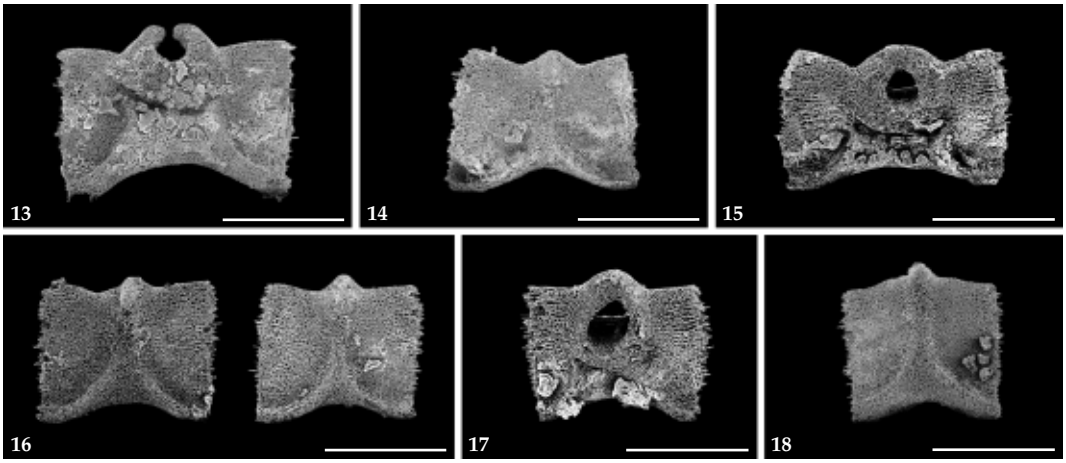
The afore mentioned differences in calcareous deposit sizes usually are thought to indicate the presence of more than a single species under the name *Chiridota pisanii*. But until now, knowledge on the variability of deposit sizes within chiridotid species is scarce. Smirnov et al. (2000) for example relate an increase in wheel size in *Chiridota hydrothermica* Smirnov & Gebruk, 2000 with somatic growth, smaller specimens have considerably smaller wheels than larger specimens. Whether this is also true for *C. pisanii* is unknown. Wheel deposit measurements are derived from specimens with a diameter close to the calcareous ring ranging from 3.8 to 5.5 mm, which is close to the total size range (3.3 to 6.3 mm) of specimens at hand. There seem to be no differences in wheel sizes between the smallest (Tab. 2: JMB-01633) and the larger specimens.

Chiridotid and synaptid holothurians have long been thought to possess a calcareous ring composed of as many pieces as there are tentacles, that is 12 tentacles should result in 12 calcareous ring plates, five radialia and seven interradialia (e.g. Clark 1908). This traditional view has changed considerably during the last years. Nowadays many of the Apodida with 12 tentacles have been shown to possess only 10 plates in the calcareous ring, with the two dorsolateral radial plates being bipartite, to allow the insertion of the additional tentacles. This has been demonstrated for all Myriotrochidae investigated hereupon (e.g. Belyaev & Mironov 1982, Gage & Billett 1986, Smirnov 1999, Bohn 2005), for some Synaptidae (e.g. Smirnov 1983, Gage 1985, Bohn unpublished data) and also for some Chiridotidae (e.g. Smirnov 1981, Smirnov et al. 2000). "Thus, according to modern views, apodid species with 12 tentacles have ten pieces of calcareous ring with two dorsolateral pieces being bipartite, i.e. bearing two anterior processes ..." (Smirnov et al. 2000: 325), but nature seems not to adhere so strictly to this "modern view".

Concerning the genus *Chiridota*, Heding (1928: 281) states that the "... calcareous ring consists in all species examined of twelve pieces". According to various authors, at least 13 of about 30 known

Tab. 4. Morphology of the calcareous ring in the genus *Chiridota* Eschscholtz, 1829 compiled from several sources. [1], as *Chirodota purpurea* Lesson, 1830.

Species	Source	
	10 plates	12 plates
Chiridota albatrossii Edwards, 1907		Heding 1928
Chiridota aponocrita H. L. Clark, 1920		Heding 1928
Chiridota carnleyensis Mortensen, 1925		Mortensen 1925
Chiridota discolor Eschscholtz, 1829	Smirnov et al. 2000	
Chiridota fernandensis Ludwig, 1898		Ludwig 1898b
Chiridota gigas Dendy & Hindle, 1907		Hickman 1962
Chiridota hawaiiensis Fisher, 1907		Fisher 1907, Heding 1928
Chiridota heheva Pawson & Vance, 2004	Pawson & Vance 2004	
Chiridota hydrothermica A. V. Smirnov & Gebruk, 2000	Smirnov et al. 2000	
Chiridota laevis (O. Fabricius, 1780)	Smirnov et al. 2000, **herein**	Heding 1935
Chiridota marenzelleri R. Perrier, 1904	Perrier 1905	
Chiridota nigra Mortensen, 1925		Mortensen 1925, Pawson 1970
Chiridota ochotensis Saveljeva, 1941	Smirnov et al. 2000	
Chiridota orientalis A. V. Smirnov, 1981	Smirnov 1981	
Chiridota pacifica Heding, 1928		Heding 1928
Chiridota pisanii Ludwig, 1886		Théel 1886[1], Heding 1928, **herein**
Chiridota rigida Semper, 1868		Heding 1929
Chiridota rotifera (Pourtalès, 1851)		Ludwig 1881, Heding 1928, **herein**
Chiridota stuhlmanni Lampert, 1896		Heding 1928, Cherbonnier 1988
Chiridota tauiensis Saveljeva, 1941	Smirnov et al. 2000	



Figs 13-18. *Chiridota rotifera* (Pourtalès, 1851), plates of calcareous ring. **13.** Mid-ventral radial plate. **14.** Left ventral interradial plate. **15.** Left ventral radial plate. **16.** Left lateral interradial plates. **17.** Left dorsal radial plate. **18.** Mid-dorsal interradial plate. Scale bars: Figs 13-18: 500 µm.

species (see Tab. 4) have been described to possess a calcareous ring with 12 pieces (e.g. Cherbonnier 1988, Fisher 1907, Heding 1928, 1929, 1935, Hickman 1962, Ludwig 1881, 1898b, Mortensen 1925, Pawson 1970, Théel 1886). On the other hand, there are currently eight species said (Tab. 4) to have a calcareous ring composed of 10 plates (Pawson & Vance 2004, Perrier 1905, Smirnov 1981, Smirnov et al. 2000), among them one of the species stated by Heding (1935) to possess 12 calcareous ring plates.

Based on own experience, the exact number of pieces constituting a calcareous ring can only be identified by dissecting, as borders separating adjoining pieces usually are concealed, and thus impossible to make out in an entire ring. To unravel these to some extent conflicting data, a detailed reexamination of *Chiridota* calcareous rings would be appropriate. To make a first move, two further species, represented in the Bavarian State Collection of Zoology, were investigated – *Chiridota laevis* (O. Fabricius, 1780) and *Chiridota rotifera* (Pourtalès, 1851).

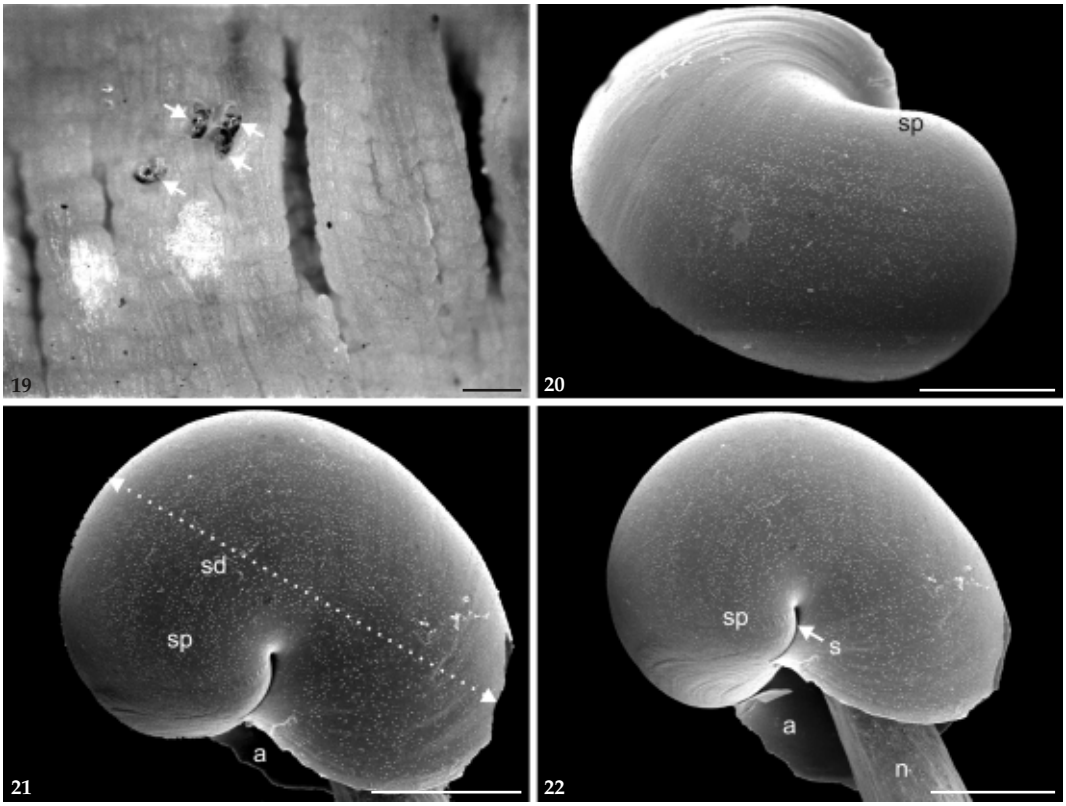
Chiridota laevis (O. Fabricius, 1780), specimen from Svalbard, Brandalpynten, 78°56.8'N 11°51.5'E, 15 m, coll. M. Hermann, 11 Jun. 2003. Calcareous ring composed of 10 pieces, five perforated radialia and five interradialia. This result is in accordance with the information given by Smirnov et al. (2000) for this species, while it refutes Heding (1935), who described the presence of 12 plates (see Tab. 4).

Chiridota rotifera (Pourtalès, 1851), specimen from Brazil, Rio de Janeiro, Búzios, Ilha do Cabloco, 0-3 m, coll. M. Schrödl, Nov. 2002. Calcareous ring composed of five radialia and seven interradialia, with two interradialia present in each lateral interradius (Figs 13-18). All radialia perforated, except for the mid-ventral one, which instead is anteriorly notched. This coincides with the data presented by Ludwig (1881) and Heding (1928).

The interpretation of these two types of calcareous ring morphologies with regard to taxonomy and phylogeny of the genus *Chiridota* is far from clear. A combination of 12 tentacles and a calcareous ring composed of 10 pieces, with the two dorsolateral radial plates beeing bipartite, probably is a synapomorphic feature for Apodida (see above; Myriotrochidae are thought to be the most basal apodid taxon, e.g. Kerr 2001), and thus is plesiomorphic for *Chiridota*. A calcareous ring composed of 12 pieces, with two interradialia in each lateral interradius, on the other hand, seems to be a synapomorphic feature of a subgroup within the genus *Chiridota* (so far demonstrated for *C. pisanii* and *C. rotifera*), that may provide useful information to reconstruct their phylogeny. But today, knowledge on the structure of the calcareous ring and its variability within the genus *Chiridota* is still too scarce, to draw any conclusions, and more reliable data are urgently needed.

Parasite

Class Gastropoda Cuvier, 1795, Superorder Caenogastropoda Cox, 1960, Order Sorbeoconcha Ponder & Lindberg, 1997, Superfamily Eulimoidea Philippi, 1853, Family Entoconchidae Gill, 1871, Genus *Entocolax* Voigt, 1888, *Entocolax* Voigt, 1888: 658. Type species (by monotypy): *Entocolax ludwigii* Voigt, 1888; recent.



Figs 19-22. *Entocolax schiemenzii* Voigt, 1901. **19.** Four juvenile specimens in their natural position on the host (arrows). **20-22.** Larval shell in different views. **a**, aperture; **n**, needle (to fix specimen on stub); **s**, suture; **sd**, shell diameter; **sp**, spire. Scale bars: Fig. 19: 500 µm, Figs 20-22: 100 µm.

Entocolax schiemenzii Voigt, 1901
Figs 12, 19-31

Entocolax sp. Ludwig, 1897: 248; 1898b: 446.
Entocolax schiemenzii Voigt, 1901: 286. Tikasingh & Pratt 1961: 65; Lützen 1979: 40.
Entocolax schiemenzi, Schwanwitsch 1917: 104; Thiele 1931: 231; Heding & Mandahl-Barth 1938: 5; Iwanow 1945: 534; 1947: 4; Skarlato 1951: 362; Warén 1983: 41.
Entocolax schimenzi [sic!], Heding 1934: 214.

Type material. Chile, Los Lagos, Calbuco, [41°45'S 73°08'W], coll. L. Plate, Nov.-Dec. 1894, in *Chiridota pisanii* specimens burried in the sand of the beach (whereabouts unknown, 2 syntypes).

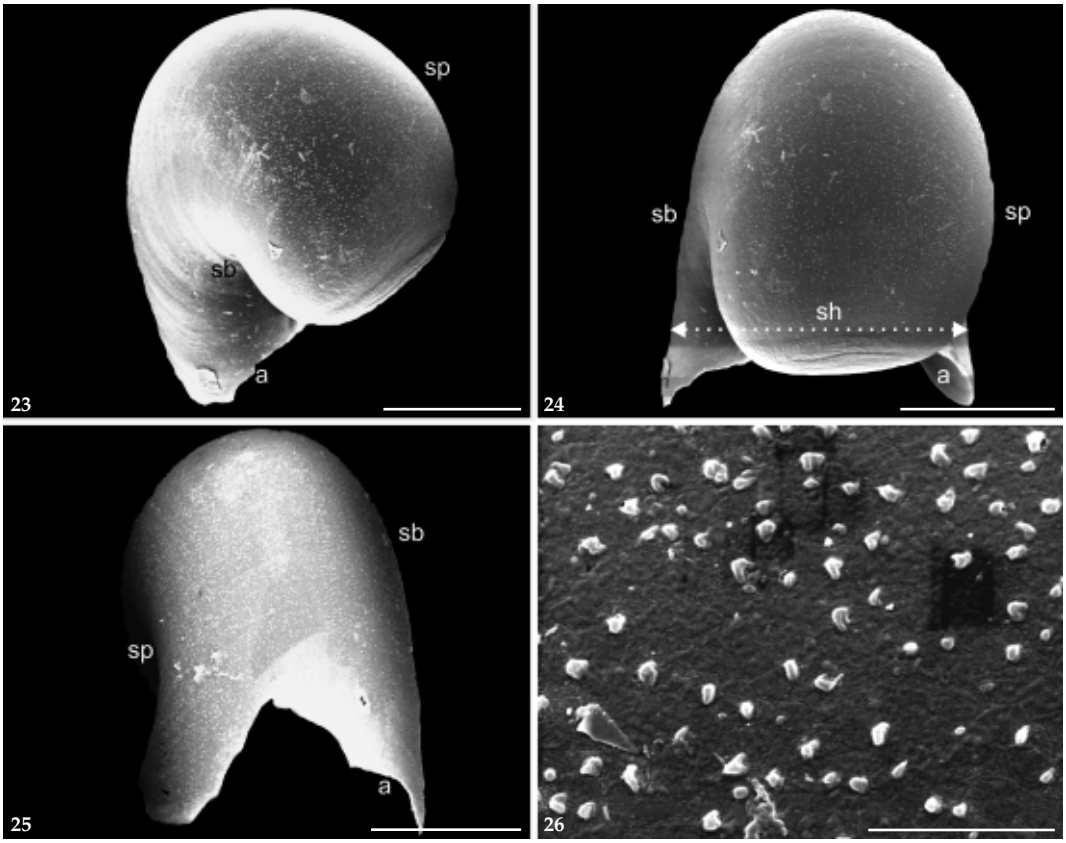
Material examined. Chile, Los Lagos, Caleta Gonzalo, [42°33'S 72°36'W], 15-25 m, coll. V. Häussermann and G. Försterra, 17 Jan. 2000, externally on a *Chiridota pisanii* specimen (ZSM Moll20051307, 4 juveniles).

Description

Four specimens attached to body wall of holothurian host (with proboscis or foot?), close to its anterior end in right dorsal interradius (Figs 1, 19), somewhat embedded in skin.

Glossy, transparent, orthostrophic, paucispiral, dextral shell smooth, thin, consists of 1.5 protoconch whorls only (Figs 21-22). Shell depressed, aperture nearly elliptical. Suture (Fig. 22) clearly indicated, umbilicus absent. Shell with microsculpture of very fine spiral threads of irregularly formed (mainly hook-like) and arranged calcareous splits (Figs 20-21, 26). Spiral bands have higher density at top of shell, become less distinct to absent towards base. Maximum shell hight may attain 200 µm (close to youngest aperture edge, Fig. 24), maximum shell diameter 308 µm (Fig. 21).

Histologically examined specimen (Figs 27-31) bent and about 282 µm long. Soft part of body, completely covered by shell, clearly differentiated into head and fleshy, elongated foot which is poste-



Figs 23-26. *Entocolax schiemenzii* Voigt, 1901. **23-25.** Larval shell in different views. **26.** Detail of the micro "sculpture" of the shell. **a**, aperture; **sb**, shell base; **sh**, shell hight; **sp**, spire. Scale bars: Figs 23-25: 100 µm, Fig. 26: 10 µm.

riorly covered by operculum, about 68 µm in diameter. Ventral mouth opens into large oesophagus, which leads into simple, sac-like stomach. Gastric shield situated on right side of stomach (Fig. 29: *gs*). Dorsally, stomach connects to intestine, which forms three loops (Fig. 27: *i*) and ends in short rectum. Anus missing. Large midgut gland situated on ventral side of stomach, consisting of two lobes, of which right one is considerably smaller. Yolk scattered throughout whole body, especially around midgut gland (Fig. 29: *y*). Foot gland (detailed structure unknown) situated in body cavity above foot anterior of operculum.

Pair of statocysts (Fig. 28: *st*) of about 21 µm in diameter situated ventrally of oesophagus. Each with single globular statolith. Dorsally, pair of eyes present (Figs 28, 31: *e*), situated at base of large cephalic tentacles (Figs 27-28, 31: *t*). Eyes smaller than statocysts, with well developed round lenses in black pigmented cup. Due to state of preservation, no other parts of nervous system could be detected.

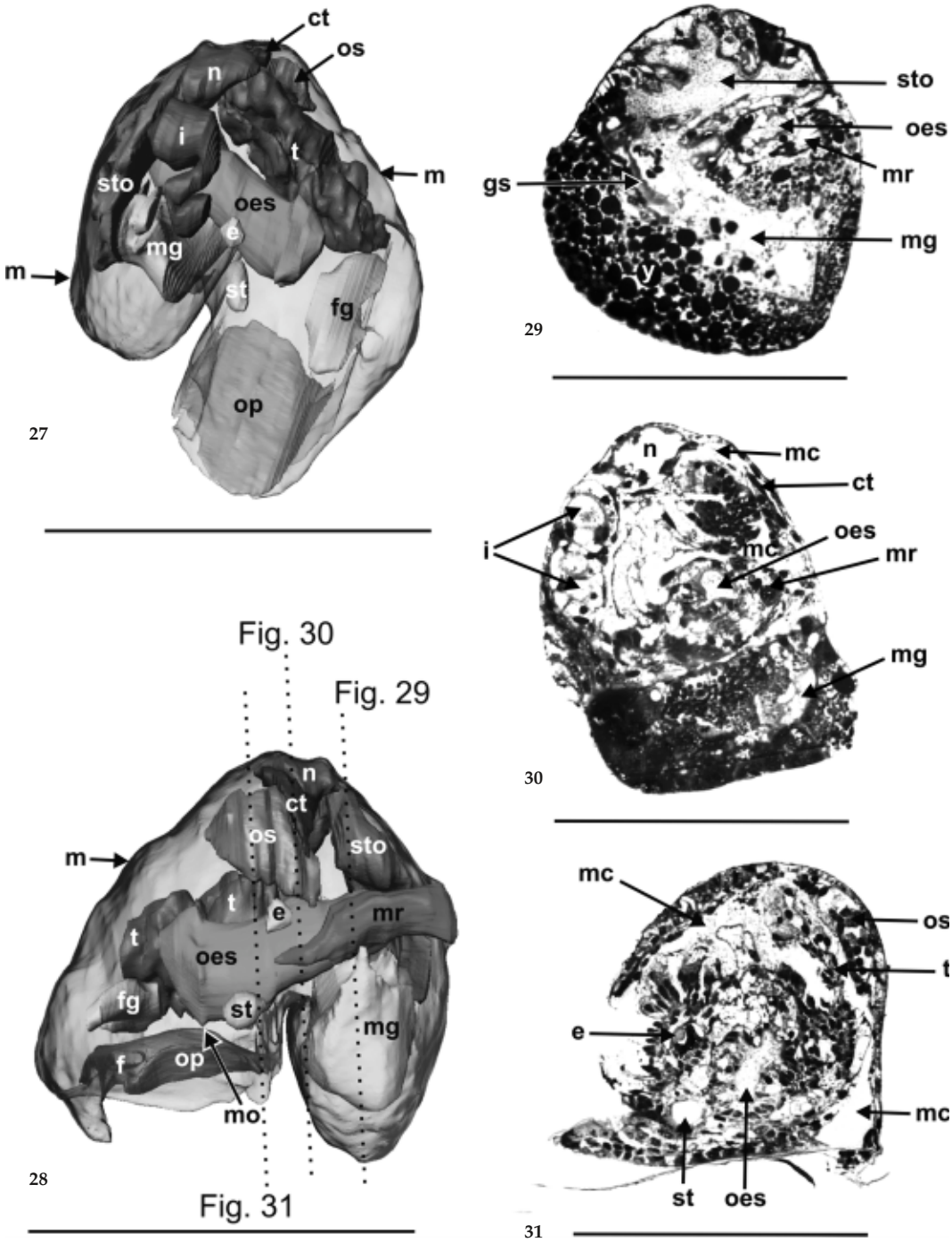
Dorsal nephridium well developed (Figs 27-28, 30: *n*), with connection to mantle cavity. No heart. Ctenidium small, on dorsal left side of body, extending into mantle cavity (Figs 28, 30: *ct*). Osphradial organ well developed, located in front of ctenidium (Figs 27-28, 31: *os*).

Retractor muscle (Figs 28-30: *mr*) attached to shell on posterior side of specimen, attains nearly half length of body.

Distribution (Fig. 12)**.** Chile, Los Lagos: Calbuco (type locality) and Caleta Gonzalo; intertidal zone to 25 m.

Remarks. In accordance with article 33.4 of the fourth edition of the International Code for Zoological Nomenclature (1999) we consider the subsequent spellings of *schiemenzii* as incorrect and use the original spelling.

There are several reasons that corroborate our belief, to address these gastropods as the juveniles



Figs 27-31. *Entocolax schiemenzii* Voigt, 1901. **27-28.** 3-D reconstruction of a juvenile. **27.** Dorso-lateral view from right side (anterior end to the right). **28.** Lateral view from left side (anterior end to the left). **29-31.** Transverse sections (1.5 µm thick). **ct**, ctenidium; **e**, eye; **f**, foot; **fg**, foot gland; **gs**, gut shield; **i**, intestine; **m**, mantle; **mc**, mantle cavity; **mg**, midgut gland; **mo**, mouth; **mr**, retractor muscle; **n**, nephridium; **oes**, oesophagus; **op**, operculum; **os**, osphradium; **st**, statocyst; **sto**, stomach; **t**, tentacle; **y**, yolk. Scale bars: Figs 27-31: 200 µm.

of the endoparasitic *Entocolax schiemenzii* which yet are undescribed.

There are only three eulimid genera known to be associated with apodid holothurians, viz. *Entocolax* with altogether six described species, and *Entoconcha* Müller, 1852 and *Mucronalia* A. Adams, 1860 with one species each (Warén 1983, Jangoux 1987). *Mucronalia variabilis* Schepman, 1914 is shelled and lives as an ecto- or endoparasite (Jangoux 1987) associated with the synaptid holothurian *Patinapta ooplax* (Marenzeller, 1881), whereas the species of the other genera are highly modified and as adults shell-less endoparasites (Warén 1983, Jangoux 1987). The larval shell morphology of our specimens fits very well with that known from species of the afore mentioned genera *Entocolax* and *Entoconcha* (see Schwanwitsch 1917, Heding 1934, Heding & Mandahl-Barth 1938). Furthermore, the only gastropod species known so far to be associated with *Chiridota pisanii* is *Entocolax schiemenzii*. Less than 100 km beeline separate the type locality (Chile: Calbuco) from the locality where our specimens have been collected.

The morphology of the juveniles too, does not contradict our assumption, that the present juvenile gastropod specimens represent *E. schiemenzii*, although knowledge so far is quite scarce. Young *E. schiemenzii* specimens have never been described nor figured in detail, but four of the six species of *Entocolax* are known to have a larval shell (see Tab. 1). Until now, the most detailed description of *Entocolax*-larvae was given by Schwanwitsch (1917), who conscientiously investigated the juveniles of *Entocolax schwanwitschi* Heding in Heding & Mandahl-Barth, 1938 (under the name *Entocolax ludwigi*). They have a velum, a simple digestive tract consisting of a pharynx and a bipartite intestine, a paired foot gland, a gonad, 3 pairs of fused ganglia and an unpaired ganglion, a retractor muscle, a pair of statocysts, yolk and an operculum. Schwanwitsch does neither mention the occurrence of eyes, an osphradium, a ctenidium nor a nephridium. Heding (1934) states the presence of a distinct velum and probably an operculum for juveniles of *E. trochodotae* Heding, 1934. Larvae of *E. rimskykorsakovi* Iwanow, 1945 posses "... a shell, a mantle, a cephalic lobe, a foot with pedal glands, and an operculum. Nervous ganglia, statocysts and a sex rudiment ..." (Iwanow 1945: 536). Later on, Schwanwitsch (1946) confirmed his previous results while studying the larval metamorphosis of *Entocolax schwanwitschi*.

Except for a velum, a sex rudiment and details concerning the nervous system (ganglia) that could not be reconstructed in our specimen, due to the state of preservation, all organs found by Schwanwitsch (1917, 1946) and Iwanow (1945) are also existent in juvenile *E. schiemenzii*. Additionally, the presence of eyes, an osphradium, a nephridium, a ctenidium and a more complex digestive system could be demonstrated.

The attachment of the adult parasites in their host, viz. to the body wall or to the intestinal tract of the host, strongly depends on the mode of live of the latter (Heding & Mandahl-Barth 1938). Holothurians, only partly buried in the sediment may become infected externally via the skin, whereas species living entirely buried in the sediment only may become penetrated via the mouth of the host, while feeding. *Chiridota pisanii* usually lives in sediment bottoms, often under stones in shallow water (see habitat paragraph of host). This corresponds well to the first scenario, that is, settlement of the juvenile parasites externally on the host. The position of the four juvenile *E. schiemenzii* specimens (exteriorly in right dorsal interradius, close to the anterior end of the host) and the position of the adult *E. schiemenzii* (within the coelomic cavity, attached to dorsal body wall, close to anterior end of host; Ludwig 1898b) both support this assumption.

A hypothetical development from a shelled juvenile, that externally settles on the skin of the holothurian, to the adult endoparasitic specimen is presented by Mandahl-Barth in Heding & Mandahl-Barth based on his examinations of *E. ludwigii*.

The presence of a well developed osphradial organ, usually serving as a chemosensory organ (Kay et al. 1998), may support the juvenile in locating a suitable host.

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22. Deas, W. & J. Deas: Coral Reefs: Natures wonders. – Western Australian Museum, 2005. 289 pp., including many colour photographs, illustrations and maps. ISBN 1-920843-18-3.

The authors, well-known and award-winning underwater photographs, created a beautiful book on one of the most fascinating structures on earth. Coral reefs are built by living animals, i.e. colonial hermatypic corals. These organisms show fleshy soft parts, the polyps, and a more or less massive skeleton made of calcium carbonate. A nicely illustrated introduction informs on the whereabouts, morphology, biology, research history and modern threats to such corals and their reefs. The second chapter concentrates on the reef builders themselves. More than 100 scleractinian coral species are briefly described and shown in underwater colour pictures. Chapter three adds a selection of further, so-called non-scleractinian coral species. Such soft corals, gorgonians and hydrocorals may simply inhabit or even somewhat contribute to the reef growth by their own skeletons or spicules. The last chapters are dedicated to reef conservation, artificial reef projects, and instructions for a sustainable tourism and suitable individual behaviour in such highly sensible and endangered environments.

In addition to wonderful photographs, of both reefs and their builders, this book offers a wealth of information for underwater enthusiasts in a narrative context. Biologists may criticise that many coral species are identified to genus rather than species level which may be, however, difficult even for specialists. The term "coral" is used in a very broad sense including anthozoan hexacorals and octocorals, and also fire and lace corals which are Hydrozoa. Especially amateur naturalists and divers would have greatly benefited from clear and straightforward introductions to higher systematic groups and their differences. A brief key would have further helped those who want to identify some unknown corals using this book. While the title suggests that a broader variety of reef-associated creatures may be included, potential purchasers should notice that the organismic part of this book is about corals and their kind only.

Michael Schroedl

23. Wehner, R. & W. Gehring: Zoologie. – Georg-Thieme-Verlag, Stuttgart, New York, 24. Auflage, 2007. 954 S., 1160 zumeist farbige Abbildungen, 17 Tabellen. ISBN 978-3-13-367424-9 (kartoniert), 978-3-13-367424-9 (gebunden)

Hiermit liegt die seit langem erwartete Neuauflage des Wehner-Gehring vor, 12 Jahre nach dem Erscheinen der letzten Auflage. In Fortsetzung der Tradition von Kühns Grundriss der Allgemeinen Zoologie handelt es sich wieder um das Bemühen zur Synthese, um Studierende von der Einheit zoologischen Forschens und Denkens zu überzeugen. Die letzte Auflage war für unzählige Studenten, den Rezensenten eingeschlossen, ein zuverlässiger Begleiter des Studiums, oft auch danach, da tatsächlich in einem überschaubaren Rahmen ein solider Einstieg in die Zoologie geliefert wurde. Vor allem war dieses Werk eine herausragende Grundlage, um in Vorlesungen und Praktika erworbenes Wissen in einen größeren Zusammenhang setzten zu können.

Was ist neu? 100 Seiten mehr, viel mehr Farbabbildungen (meist die aus den letzten Ausgaben bekannten Abbildungen in überarbeiteter Form) und Fotos, Kapitel durch Farbkodierung an der Buchvorderseite hervorgehoben – und vor allem: Diese Auflage liegt in einem etwa doppelt so großen Format vor, welches neben dem Fliesstext einen 8 cm weiten Rand bietet – der auf vielen Seiten durch zusätzliche Abbildungen u.ä. bevölkert wird. Das größere Format hat es nun erlaubt, die in den Abbildungen dargestellten wichtigen Strukturen mit einer Textbeschriftung zu versehen (Mundöffnung, Ventralnerv), anstatt der früher verwendeten, unpraktischen Kürzel (Mu, Nv). Das Textbild ist klarer, wie auch die Textaufteilung.

Zum Inhalt. Die Kapitel sind in gewohnter Abfolge organisiert – Struktur und Funktion der Zelle, Vererbung, Entwicklung, Stoff- und Energiewechsel, Hormonale Koordination, Sinnesleistungen, Bewegung, Verhalten, Ökologie, Evolution, Vielfalt der Organismen (dem mit Abstand umfangreichsten Kapitel). Letzteres wird mit einer kompakten Einführung in die phylogenetische Systematik eröffnet, und positiv fällt auf, dass das gesamte Kapitel dann weit systematischer aufgebaut ist als in vorhergehenden Auflagen. So finden sich nun zahlreiche Stammbäume, die es dem Leser erleichtern, sich im zoologischen System zurecht zu finden. Leider sind diese Stammbäume ohne wichtige Merkmale an den Knoten dargestellt, also reine Verzweigungen, können aber sicher als Anreiz dienen, die Merkmalsprojektion selber nachzuholen. Konsequenterweise wurden aus Reptilia (Kriechtiere) (23. Auflage, S. 766) nun Sauropsida (exkl. Aves) (S. 834). Als Neuzugang wird die erst 2002 beschriebene Insektenordnung Mantophasmatodea in einer Box ausführlich vorgestellt, ein Lichtblick, da die hyperdiversen pterygoten Insekten, wie früher schon, für den Geschmack des Rezensenten viel zu kurz kommen. Im Evolutionskapitel wird etwas mehr auf molekulare Methoden bei der Stammbaumrekonstruktion eingegangen, und die Evolution der Hominiden ist zum Beispiel deutlich ausführlicher dargestellt als zuvor.

Durch die umfangreiche Revision und Aktualisierung der Texte erscheint mir diese Neuauflage lesbarer als ihre Vorgänger. Das Buch gewinnt auch durch die großzügigere farbliche Gestaltung und Formatvergrößerung an Klarheit. Alles in allem – ein schöner Einstieg in die Zoologie.

Michael Balke