New species of *Hexapathes* Kinoshita, 1910 (Anthozoa, Antipatharia, Cladopathidae) from the South-West Pacific

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ABSTRACT
Two new species of the genus *Hexapathes* Kinoshita, 1910 (Antipatharia, Cladopathidae, Hexapathinae), *H. hivaensis* n. sp. from Marquesas Islands and *H. alis* n. sp. from Fiji, are described. Both species were found on the slope at depths of 400-430 m. *Hexapathes hivaensis* n. sp. differs from the closely related *H. heterosticha* Kinoshita, 1910 by thicker, distinctly curved and denser arranged lateral pinnules and smaller polyps. *Hexapathes alis* n. sp. differs from the related *H. australiensis* Opresko, 2003 by the form of the colony and relative length of lateral pinnules. A brief review of the genus *Hexapathes* is given and the possibility of existence of dimorphic polyps in the genus *Heliopathes* Opresko, 2003 is discussed.

KEY WORDS
Anthozoa,
Antipatharia,
Cladopathidae,
Hexapathinae,
Hexapathes,
Heliopathes,
French Polynesia,
Marquesas,
Fiji,
new species.

RÉSUMÉ
*Nouvelles espèces d'*Hexapathes *Kinoshita, 1910 (Anthozoa, Antipatharia, Cladopathidae) du Sud-Ouest Pacifique.*
Deux nouvelles espèces du genre *Hexapathes* Kinoshita, 1910 (Antipatharia, Cladopathidae, Hexapathinae), *H. hivaensis* n. sp. de l'archipel des Marquises et *H. alis* n. sp. de l'archipel des Fidji, sont décrites. Les deux espèces ont été récoltées sur le talus des îles à une profondeur de 400-430 m. *Hexapathes hivaensis* n. sp. est proche de *H. heterosticha* Kinoshita, 1910 mais se distingue par des pinnules latérales plus grosses, plus serrées et très incurvées en arrière, et aussi par des polypes relativement petits. *Hexapathes alis* n. sp. se distingue de l'espèce apparentée *H. australiensis* Opresko, 2003 par la forme du polypier et la longueur relative des pinnules latérales. Un tableau comparatif des caractères des différentes espèces du genre *Hexapathes* est proposé. La possibilité de polypes dimorphes dans le genre *Heliopathes* Opresko, 2003 est discutée.

MOTS CLÉS
Anthozoa,
Antipatharia,
Cladopathidae,
Hexapathinae,
Hexapathes,
Heliopathes,
Polynésie française,
Marquises,
Fidji,
espèces nouvelles.

INTRODUCTION

The genus *Hexapathes* was established by Kinoshita (1910) in the subfamily Cladopathinae for *H. heterosticha*, a new species from deep waters of Sagami Bay (Japan) characterized by a monopodial corallum with simple pinnules arranged in two lateral and anterior rows and polyps with an actinopharynx and six primary and no secondary mesenteries. During almost a century no new records of this species were reported. Opresko (2003) in his revision of the family Cladopathidae established a new subfamily Hexapathinae for the two genera: *Hexapathes* and a newly established genus *Heliopathes* Opresko, 2003, differing from the former by the longer lateral pinnules extending beyond the top of the stem and subpinnulated anterior pinnules with larger spines. He also described two new species in the subfamily: *Hexapathes australiensis* Opresko, 2003 and *Heliopathes americana* Opresko, 2003, both from bathyal depths (520 m and 2200 m, respectively).

In the present paper two new species of *Hexapathes* from the South-West Pacific are described and some characters of corallum of the genera *Hexapathes* and *Heliopathes* are discussed.

ABBREVIATIONS

CP	beam trawl;
IORAS	Institute of Oceanology of the Russian Academy of Sciences, Moscow;
IRD	Institut de Recherche pour le Développement;
MNHN	Muséum national d'Histoire naturelle, Paris;
MSU	Moscow State University;
RV	research vessel.

MATERIAL AND METHODS

The material investigated was collected during cruises MUSORSTOM 9 (Richer de Forges *et al.* 2000) and BORDAU 1 (Richer de Forges *et al.* 1999). Specimens were initially preserved in 4% seawater buffered formol and then transferred to 70% alcohol. All measurements of the corallum were carried out after preservation. The spines were measured using SEM images as well as light microscopy of the skeleton. The transversal diameter of polyps was measured as a distance between the distal edge of distal lateral tentacles to proximal edge of proximal lateral tentacles of the same polyp. The distance between spines was chosen as a distance measured between centers of the bases of adjacent spines in the same longitudinal row; the height of the spine was chosen as a distance between the apex and the center of the base of a corresponding spine.

SYSTEMATICS

Family CLADOPATHIDAE Kinoshita, 1910
Subfamily HEXAPATHINAE Opresko, 2003

Genus *Hexapathes* Kinoshita, 1910

TYPE SPECIES. — *Hexapathes heterosticha* Kinoshita, 1910; type locality: Japan, Sagami Bay, 730 m.

DIAGNOSIS. — Corallum simple or very sparsely branched, and pinnulate. Pinnules in two lateral rows and in one or two anterior rows. Lateral pinnules simple; anterior pinnules simple or subpinnulate. Anterior primary pinnules and subpinnules sometimes nearly as long as lateral pinnules. Spines subequal in size on primary and secondary pinnules. Polyps 3 to 6 mm in transverse diameter.

Hexapathes hivaensis n. sp.
(Figs 1; 2A, B; 3)

TYPE MATERIAL. — Holotype: French Polynesia, Marquesas, off Nuku Hiva, RV *Alis*, MUSORSTOM 9, CP 1300, 8°49.9'S, 140°17.4'W, 416-430 m (MNHN, alcohol-preserved specimen).

ETYMOLOGY. — The specific name "hivaensis" is derived from "Hiva", ancient Polynesian name of the Marquesas Islands.

DISTRIBUTION. — The species is known only from the type locality.

DIAGNOSIS. — Corallum (Fig. 1) monopodial and pinnulate. Primary pinnules in two lateral rows and two irregular anterior rows. Lateral pinnules simple, elongated, arranged alternately, except for the most basal ones that are subopposite; inclined and curved distally and backwards relative to the polyp side of the corallum. Anterior pinnules (Fig. 2A) simple and of varying

FIG. 1. — *Hexapathes hivaensis* n. sp., holotype, entire corallum. Scale bar: 2 cm.

length, often as long as lateral pinnules, extended out almost perpendicular to the plane containing the stem and lateral pinnules. Spines on pinnules small (Fig. 3), triangular to conical in lateral view, smooth, mostly 0.03-0.05 mm at lateral pinnules and up to 0.09 mm at anterior pinnules, arranged in irregular axial rows, five to seven of which are visible in side view. Polyps (Fig. 2B) 3.1-5.3 mm in transverse diameter, with long oral cone up to 3.0-3.5 mm, arranged in one series with up to 2.5-3 polyps per cm.

DESCRIPTION OF THE HOLOTYPE

The holotype is a colony broken just above the basal plate (Fig. 1), 18.5 cm tall and has a maximum width of pinnulated part of 19.5 cm. The stem

FIG. 2. — **A**, **B**, *Hexapathes hivaensis* n. sp., holotype; **A**, arrangement of pinnules; **B**, polyps; **C**, **D**, *Hexapathes alis* n. sp., holotype; **C**, entire corallum; **D**, arrangement of pinnules. Scale bars: A, D, 1 cm; B, 0.5 cm; C, 2 cm.

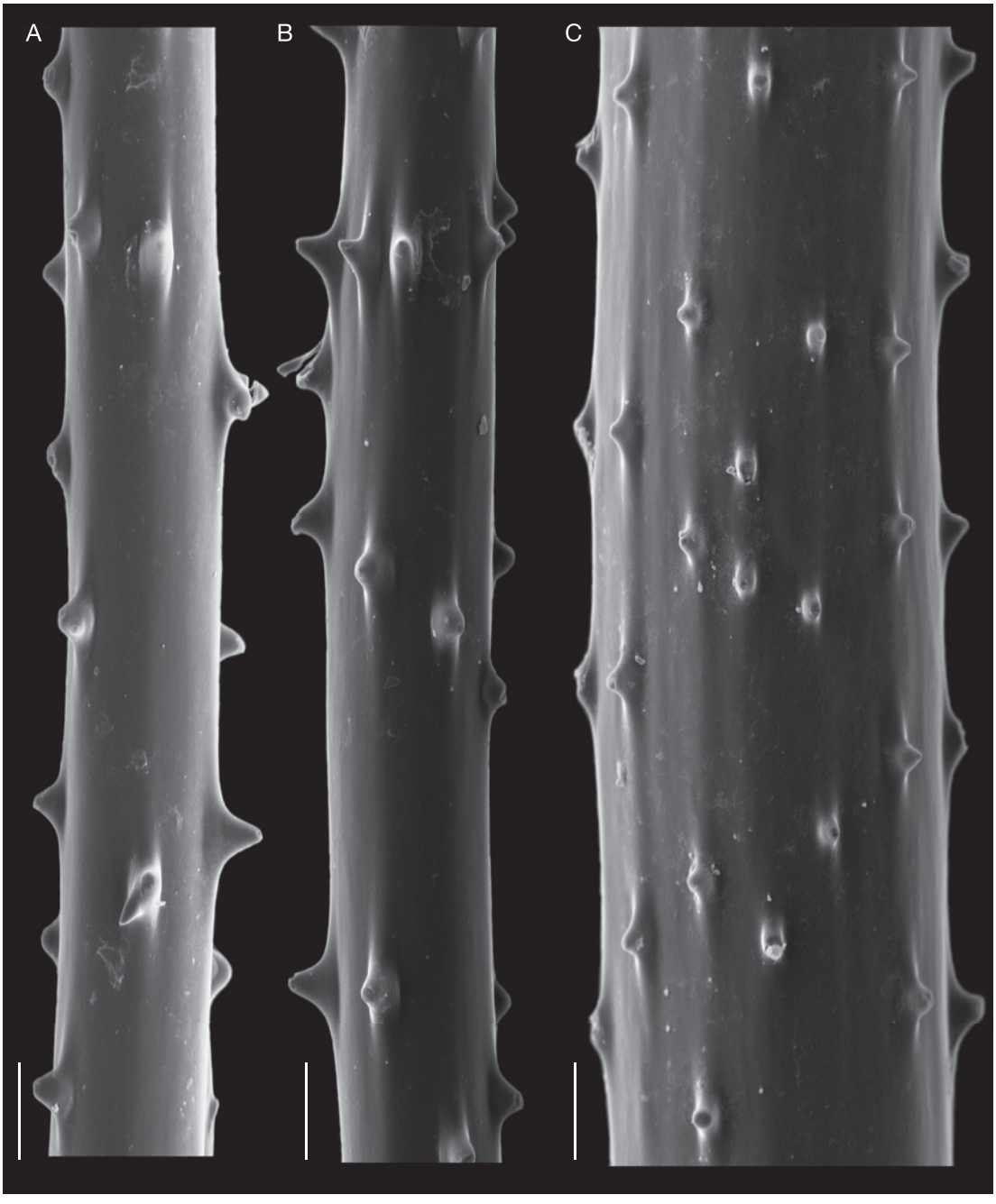

FIG. 3. — *Hexapathes hivaensis* n. sp., holotype, spines of pinnules: **A**, **B**, anterior; **C**, lateral. Scale bars: 0.1 mm.

has a basal diameter of 1.75 mm and 2.25 mm just below the bases of the lowest lateral pinnules. The lowermost 2.4 cm of the stem lack pinnules and the upper 2 cm of it are fluted with narrow grooves and ridges.

Pinnules are arranged in two lateral and two anterolateral rows. Lateral pinnules are long and curved distally and backwards relative to the polyp side of the corallum in such a way that tips of the pinnules are meeting at the back side of the corallum. On the lowermost part of pinnulated section of the stem the planes of lateral rows form an angle of 130°, at higher parts of the colony they lay nearly in the same plane. The lowermost pair of lateral pinnules is opposite and perpendicular to the stem. All other lateral pinnules arranged alternately and inclined distally with distal angle of 20-80°. The length of the lateral pinnules increases from the lowermost (3.5-5 cm) to the middle part of the colony (13-15 cm) and then remains practically the same, slightly diminishing only at the apex of the colony. Basal diameter of laterals is 0.6-1.3 mm. In each lateral row the pinnules are spaced 2.1-4.5 mm apart, the distance increases gradually toward the apex of the colony.

The anterolateral pinnules are simple (Fig. 2A); 3-4 cm up to 10-11 cm, diminishing to the apex of the colony. They are not found on the part of the corallum corresponding to the two lowermost pairs of lateral pinnules and seem to be more crowded in the middle part of the colony. Anterolateral pinnules are inserted almost perpendicularly to the axis and curved laterally reiterating the form of lateral pinnules at the same level.

Pinnular spines (Fig. 3) are small, smooth, triangular to conical in lateral view, perpendicular to axis or slightly inclined proximally or laterally. Forked spines were encountered (Fig. 3A). The spines are mostly 0.03-0.06 mm tall (up to 0.09 mm) arranged in irregular rows 0.13 to 0.5 mm apart. There are five to seven spines visible in lateral view with four to five spines per mm in each row.

Polyps (Fig. 2B) are dark-vinaceous in color, elongated along the transversal axis, arranged in single row along the pinnules. The transversal diameter of polyps range from 3.1 to 5.3 mm with interpolypar distance ranging from 0.9 to 2.8 mm. There are two to three polyps per cm. The morphology of the polyps with enormously elongated oral cones (up to 3-4 mm) that often exceed the length of tentacles (0.4-6 mm, mainly 0.5-2.5 mm) fits well with that described by Kinoshita (1910) for *Hexapathes heterosticha*. Polyps with gonads are mainly concentrated at the proximal region of anterolateral pinnules and at the bases of lateral pinnules.

A commensal polynoid polychaete was recorded on the colony.

Comparisons

The new species closely resembles the type species of the genus, *Hexapathes heterosticha* by the general form of the colony and the polyps, but differs from this species by having thicker (0.8-1.4 mm compared to 0.65 mm) distinctly curved and more densely arranged (2.1-4.5 mm and 2.5-6 mm respectively) lateral pinnules and smaller polyps (3.1-5 mm and 5-9 mm). *Hexapathes hivaensis* n. sp. differs from *H. australiensis* and *H. alis* n. sp. by lacking of secondary pinnules.

Hexapathes alis n. sp.
(Figs 2C, D; 4)

Type material. — Holotype: Fiji Islands, RV *Alis*, BORDAU 1, CP 1412, 16°05.52'S, 179°28.05'W, 400-407 m (MNHN, alcohol-preserved specimen).

Etymology. — The specific name "alis" is after RV *Alis* of the IRD centre in Nouméa, New Caledonia.

Distribution. — The species is known only from the type locality.

Diagnosis. — Corallum (Fig. 2C) monopodial and pinnulate. Primary pinnules in two lateral rows and in one or more irregular anterior rows. Lateral pinnules simple, elongated, arranged alternately except for the most basal ones that are subopposite; inclined distally with curved distal part. Anterior pinnules (Fig. 2D) simple or with one or two secondary pinnules, of varying length, always shorter than lateral pinnules, inclined distally, more densely set than lateral ones. Spines on pinnules (Fig. 4) small, triangular to conical in lateral view, smooth, 0.03-0.09 mm tall, mostly 0.04-0.07 mm, arranged in irregular axial rows, five to seven of which are visible in side view. Polyps estimated to be 2.5-6 mm in transverse diameter.

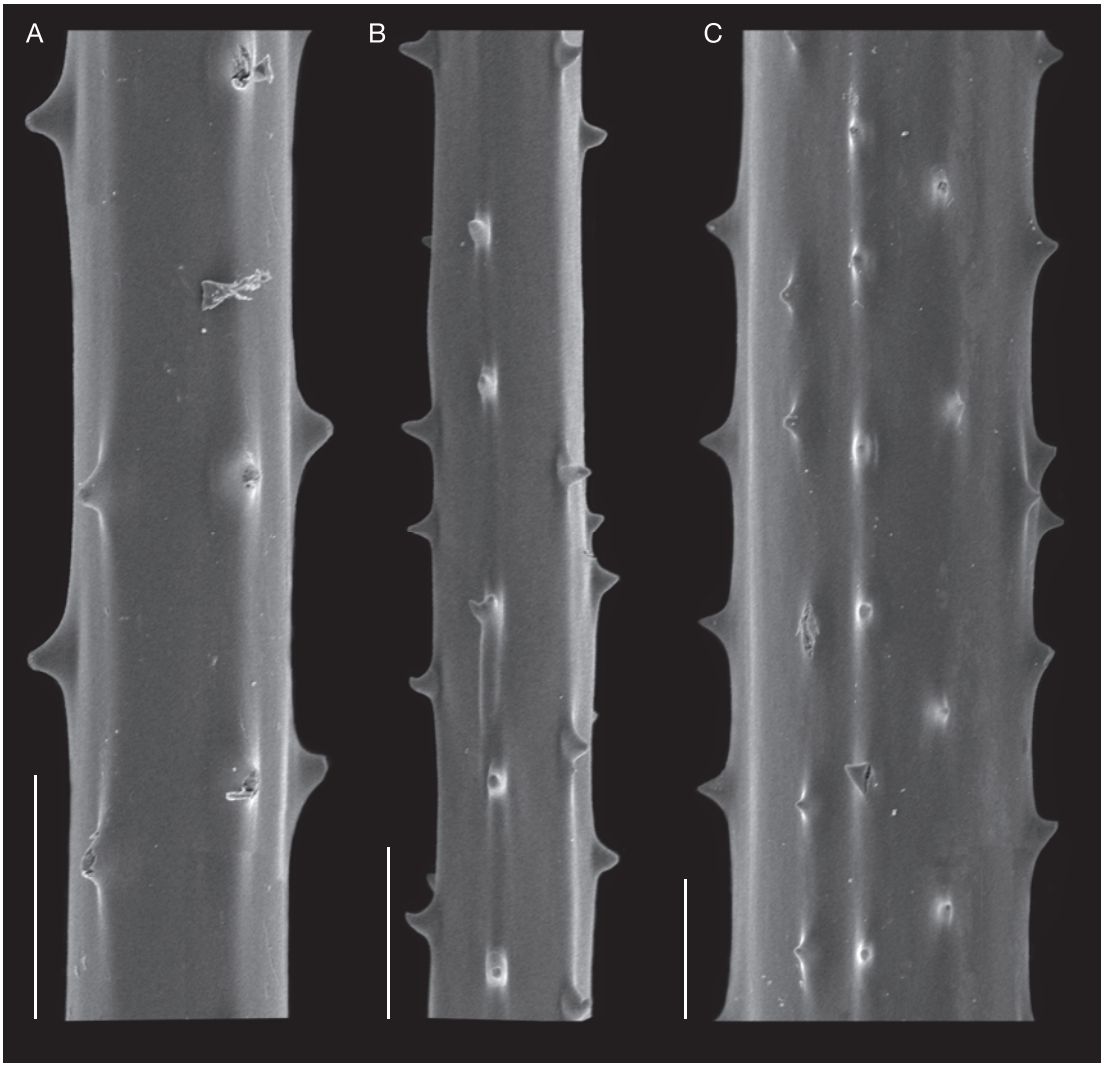

FIG. 4. — *Hexapathes alis* n. sp., holotype, spines of pinnules: **A**, **C**, lateral; **B**, anterior. Scale bars: 0.1 mm.

DESCRIPTION OF THE HOLOTYPE

The holotype (Fig. 2C) is a complete colony with a basal plate, 21 cm tall and has a maximum width of pinnulated part about 20 cm. Diameter of the basal plate is 1.1 cm. Just above the base the stem is 1.8 mm in diameter, increasing to 2.5 mm 1 cm above the base. The lowermost 2.5 cm of the stem lack pinnules and are fluted with narrow grooves and ridges.

Pinnules are arranged in two lateral and one or two anterior rows. Lateral pinnules are long, straight in the proximal part and curved distally. On the lowermost part of pinnulated section of the stem both lateral rows are nearly in the same plane, at higher points the angle becomes more obtuse (220-240°). The lowermost pair of lateral pinnules is opposite and almost perpendicular to the stem (85°). All other lateral pinnules are arranged alternately and

inclined distally with a distal angle of 30-60°. The length of the lateral pinnules increases from the base (3-9 cm) to the middle part of the colony (15 cm), diminishing towards the apex. Basal diameter of laterals is 0.9-1.3 mm. In each lateral row the pinnules are spaced 3.5-15 mm apart, the distance increases gradually toward the apex of the colony.

The anterior pinnules (Fig. 2D) are 1-6.5 cm long, mostly 3-4 cm, and seem to form a single more densely set row. They are not found on the part of the corallum corresponding to three lowermost pairs of lateral pinnules and more crowded at distal third of the colony. Anterior pinnules also inclined distally forming an angle of 30-60°. Subpinnules occur irregularly at some of anterior pinnules. Usually only one subpinnule occurs at each anterior pinnule, but rarely two subpinnules were encountered at the same anterior primary. Subpinnules have the same length and appearance as corresponding primaries.

Pinnular spines (Fig. 4) are small, smooth, triangular to conical in lateral view, and perpendicular to the axis. In the distal part of pinnules spines seem to be arranged on longitudinal ridges. Forked spines occur near the base of lateral pinnules. The spines are mostly 0.04-0.07 mm tall (up to 0.09 mm) arranged in four to six rather irregular rows visible in lateral view, 0.1-0.9 mm apart in the same row resulting in three to five spines per mm. The distance between adjacent spines of the same row varies from 0.1 to 0.9 mm.

Polyps are in poor state of preservation and estimated to be 2.5-6 mm in transverse diameter. Polyps with gonads were located at the base of secondary pinnules.

Comparisons

In the presence of the secondary subpinnules on the anterior primaries *Hexapathes alis* n. sp. resembles *H. australiensis*. The new species differs from the latter by having thicker pinnules (0.9-1.3 mm and 0.5, correspondingly) as well as by having longer (up to 15 cm and up to 10.5 cm) curved lateral pinnules. Appearance of the colony, longer lateral pinnules resemble those of *H. heterosticha* and *H. hivaensis* n. sp. However these two species could be easily distinguished from *H. alis* n. sp. by the absence of secondary pinnules and longer anterior pinnules (up to 11 cm in compare with up to 6 cm in *H. alis* n. sp.) arranged in two distinctive rows.

DISCUSSION

With two species described herein, the genus *Hexapathes* now includes four species. All species of the genus *Hexapathes* are characterized by typical morphology of the corallum: long, alternated, straight or curved, lateral pinnules and anterior pinnules arranged in one or two rows, sometimes with scattered subpinnules. The main characteristics of *Hexapathes* species are summarized in Table 1. As it is possible to see from Table 1, the size and morphology of the polyps and spines, and the form of the corallum of *H. alis* n. sp. and *H. hivaensis* n. sp. clearly show that they are distinctive new species. The situation with limited material is common with animals inhabiting steep slopes and crevices of oceanic rises that are hardly accessible for such gears as dredges and trawls. Much better results can be expected using manned submersibles.

The original description of the type species of the genus *Hexapathes*, *H. heterosticha* (Kinoshita 1910: 231-324, figs A-C), did not include any illustrations of the entire corallum. It is rather brief and, as it can be well seen from the Table 1, it does not reflect all particularities of colony morphology. Thus, there is no information about the form and position of the lateral pinnules, which are quite distinctive in other species of the genus. However, the form of the spines, illustrated in the description of *H. heterosticha* differs well from those of both species described herein as well as from *H. australiensis* (Opresko 2003: 527-531, figs 15, 16). The type specimens of *H. heterosticha* were not located to date. One can suppose that they were deposited at the University Museum of the Tokyo University where Dr Kinoshita used to work, but there is no information about these type specimens in the catalogue of the University Museum (Dr Hiroshi Namikawa pers. comm.).

Two newly described species, *H. alis* n. sp. and *H. hivaensis* n. sp., resemble the species of closely related genus *Heliopathes* in their long curved lateral

TABLE 1. — Comparison of the four species of *Hexapathes* Kinoshita, 1910.

	***H. heterosticha* Kinoshita, 1910**	***H. australiensis* Opresko, 2003**	***H. alis* n. sp.**	***H. hivaensis* n. sp.**
Colony height (cm)	20	25	21	18.5
Colony width (cm)	19	7	20	19.5
Basal diameter of the stem (mm)	2	0.8 × 0.9	1.8	1.75
Unpinnulated region (cm)	2	2.5	2.5	2.4
Ridges and grooves at stem	?	present	present	present
Lateral pinnules	directed obliquely above	straight; inclined distally (60°)	curved at ends; inclined distally (30-60°)	curved; inclined distally (20-80°)
Arrangement of laterals	?	lowermost opposite, other alternate	lowermost opposite, other alternate	lowermost opposite, other alternate
Anterior pinnules	directed horizontally	basal perpendicular, upper inclined distally (70-80°)	inclined distally (30-60°)	perpendicularly to the stem and curved laterally
Length of laterals (cm)	up to 14	5 up to 10.5	3-9 to 15	3.5-5 to 13-15
Length of anteriors (cm)	up to 10	2-3 to 6	1-6.5	3-4 to 10-11
Distance between laterals (mm)	2.5-6	4-11	3.5-15	2.1-4.5
Basal diameter, of laterals (mm)	0.6	0.5	0.9-1.3	0.6-1.3
Subpinnules	absent?	up to 1	up to 2	absent
Spine morphology	conical, laterally compressed, perpendicular to the axis or inclined distally	triangular to conical, laterally compressed, perpendicular to axis or inclined distally	triangular to conical laterally compressed, perpendicular to axis	triangular to conical laterally compressed, perpendicular to axis or inclined distally or proximally
Spine size (mm)	0.05-0.10	0.08-0.12 (up to 0.14)	0.04-0.07 (up to 0.09)	0.04-0.07 (up to 0.09)
Polypar spines	larger, more inclined	larger	no significant difference	no significant difference
Axial rows	6-9 (total?)	3-5 in side view	4-6 in side view	5-7 in side view
Spine distance	0.35-0.6 mm apart	3-4 per 1 mm	3-5 per 1 mm	4-5 per 1 mm
Polyps	5-9 mm; high oral cones	3-4 mm	2.5-6 mm	3.1-5 mm (oral cones up to 3-4 mm); 2-3 polyps per 1 cm
Polyps with gonads	?	at bases of subpinnules	at bases of subpinnules	at bases of laterals and proximal part of anterolaterals

pinnules extending up to the top of the stem. On account of corallum morphology of the two new species of *Hexapathes* the statement "lateral pinnules generally do not extend beyond the top of the stem" (Opresko 2003) has to be excluded from the diagnosis of the genus *Hexapathes*. So far species of *Heliopathes* differ from those of *Hexapathes* only by more intensively pinnulated anterior pinnules and larger spines on anterior pinnules and subpinnules compared to those on lateral pinnules. The size of polyps and general form of corallum are practically the same.

It is interesting to note the arrangement of polyps with gonads in the genus *Hexapathes*. There is no information if *H. heterosticha* had any polyps with developed gonads, however this information is available for the three other species of the genus. In *H. hivaensis* n. sp., which has no subpinnules, the polyps with gonads are located mainly at the bases of lateral pinnules and at a proximal third

of anterolateral pinnules. In *H. australiensis* and *H. alis* n. sp. polyps with mature gonads were mentioned only at the bases of the subpinnules of anterior row and never on the lateral pinnules. In the genus *Heliopathes* (Cooper 1909; Opresko 2003) no polyps were mentioned, but the remains of soft tissue covering anterior subpinnules often contained eggs. In the same way a specimen of an undescribed *Heliopathes* species from IORAS collection (Molodtsova pers. obs.) contained developed gonads in tissue covering anterior subpinnules with no traces of polyps.

It is possible that in the genus *Heliopathes* there are two types of polyps: vegetative polyps located on the stem and lateral pinnules and generative polyps arranged on subpinnules of the anterior row. In such a way numerous subpinnules and longer spines of the anterior row in the species of the genus *Heliopathes* are an adaptation to anchoring these generative polyps which after maturing of the gonads turn into bulks of a gonad-containing tissue.

The hypothesis of dimorphic polyps was already discussed in the literature. Thus, Brook (1889) in his account of microscopic anatomy of antipatharians of the *Challenger* expedition regarded large polyps of *Schizopathes* Brook, 1889 as subdivided into a central gastrozooid containing the stomodaeum and two lateral gonozooids, bearing reproductive organs. This was later discussed in a number of papers (Van Beneden 1897; Delage & Hérouard 1901; Pax 1940). In the case of *Heliopathes* there are no signs for such a functional subdivision between parts of a single polyp, but the gonad-bearing polyps may be located in a particular region of the corallum. More material is required to test this hypothesis.

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